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Product Standard PS1-83
Construction and Industrial Plywood

Product Standard PS1-83, Construction and Industrial Plywood, supersedes PS1-74 and PS 1-66, Construction and Industrial Plywood; CS45-60, Douglas-Fir Plywood; CS122-60, Western Softwood Plywood, and CS259-63, Southern Pine Plywood.

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U.S. Product Standard PS 1-83

**FOR CONSTRUCTION
& INDUSTRIAL PLYWOOD*
WITH TYPICAL APA
TRADEMARKS**

Effective Date December 30, 1983,

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FOREWORD

Product Standard PS 1-83, reproduced in the following pages, provides expanded and updated requirements for producing, marketing, and specifying plywood for construction and industrial uses.

It covers manufacture of such plywood from some 70 wood species and supersedes the product standard published in 1974.

The Office of Product Standards Policy of the National Bureau of Standards assists in development of voluntary product standards on a nationwide basis through the cooperative efforts of producers, distributors, consumers, and users.

The role of the National Bureau of Standards in the establishment of a Voluntary Product Standard is to (1) act as an unbiased coordinator in the development of the standard, (2) provide editorial assistance in the preparation of the standard, (3) supply such assistance and review as is required to assure the technical soundness of the standard, (4) seek satisfactory adjustment of valid points of disagreement, (5) determine the compliance with the criteria of the Department's procedures, and (7) publish the standard as a public document.

It must be emphasized that the Department of Commerce has no regulatory authority or enforcement power to police the provisions of this or other product standards, but, inasmuch as the standard represents the consensus of the industry, its provisions are established by trade custom and are made effective through incorporation by reference in sales contracts, federal specifications, building codes, purchase invoices, advertising, and similar means.

The text of PS 1-83, prepared from material supplied by the National Bureau of Standards, is set forth in this publication. In addition, the American Plywood Association's trademarks, which do not appear in the Government Printing Office version, are explained and illustrated on pages 43 and 44.

TABLE OF CONTENTS

SECTION	PAGE
1. Purpose	6
2. Scope and Classification	6
2.1. Scope	6
2.2. Classification	6
2.2.1. Exposure capability	6
2.2.1.1. Interior type	6
(a) Bonded with interior glue	6
(b) Bonded with intermediate glue	6
(c) Bonded with exterior (waterproof) glue identified as "Exposure 1"	6
2.2.1.2. Exterior type	6
2.2.2. Grade	6
3. Requirements	7
3.1. General	7
3.2. Wood species	7
3.2.1. Species groups	7
3.2.1.1. Species segregation	7
3.2.2. Species for faces and backs	7
3.2.3. Species for inner plies	7
3.3. Synthetic repairs	8
3.3.1. Synthetic fillers	8
3.3.2. Synthetic shims, patches and plugs	8
3.4. Grade description of veneers	8
3.4.1. Grade N veneer (intended for natural finish) ...	8
3.4.2. Grade A veneer (suitable for painting)	8-9
3.4.3. Grade B veneer	9
3.4.4. Grade C veneer	9-10
3.4.4.1. C Plugged veneer	10
3.4.5. Grade D veneer	10-11
3.5. Veneers and layers	11
3.5.1. Veneer thickness	11
3.5.2. Parallel laminated layers	11
3.5.3. Scarfed veneers	11

SECTION

PAGE

3.6.	Panel grades	12
3.6.1.	Marine	12
3.6.2.	Decorative panels	13
3.6.3.	Underlayment, C-C Plugged	13
3.6.4.	B-B concrete form panels	13-14
3.6.5.	Structural panels	14
3.6.6.	Interior type bonded with exterior glue (Exposure 1)	14
3.6.7.	Special exterior	14
3.6.8.	Overlays	14
3.6.8.1.	High Density Overlay	14
3.6.8.2.	Medium Density Overlay	14-15
3.6.8.3.	Special overlays	15
3.7.	Adhesive bond requirements for a panel or a lot	15
3.7.1.	Interior type bonded with interior glue	15
3.7.1.1.	Mold resistance: Underlayment, C-D Plugged and C-D	15
3.7.1.2.	Resistance to elevated temperature: Under- layment, C-D Plugged and C-D	15
3.7.2.	Interior type bonded with intermediate glue ...	15-16
3.7.2.1.	Intermediate glue heat durability	16
3.7.2.2.	Bacteria-mold resistance	16
3.7.3.	Interior type bonded with exterior glue (Exposure 1)	16
3.7.3.1.	Interior type bonded with exterior glue (Exposure 1) heat durability	16
3.7.4.	Exterior type	16
3.7.4.1.	Exterior glue heat durability	16
3.7.4.2.	Overlaid plywood	16
3.8.	Panel constructions and workmanship	17-18
3.8.1.	Crossband gaps and center gaps	18
3.8.2.	Veneer requirements	18
3.8.3.	Sanded panels	18
3.8.4.	Unsanded and touch-sanded panels	19-20
3.8.5.	Span Ratings for unsanded and touch-sanded panels	21
3.8.6.	Performance testing qualification require- ments	21
3.8.6.1.	General	21-22
3.8.6.2.	Performance testing	22
3.8.6.3.	Structural performance	22-23
3.8.6.4.	Bond durability	23
3.8.6.5.	Product evaluation	23-24
3.8.6.6.	Reexamination	24

SECTION	PAGE
3.9. Scarf and finger jointed panels	24
3.9.1. Strength requirements (Interior and Exterior) . .	24
3.9.2. Scarf and finger joint durability for Interior panels bonded with interior glue	24
3.9.3. Scarf joint durability for Exterior type plywood and Interior type bonded with exterior glue (Exposure 1) or intermediate glue	24
3.9.4. Finger joint durability for Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or or intermediate glue	24
3.10. Dimensional tolerances and squareness of panels	25
3.10.1. Size tolerances	25
3.10.2. Thickness tolerances	25
3.10.3. Squareness and straightness	25
3.11. Moisture content	25
3.12. Loading or packing	25
4. Specimen Preparation and Testing	25
4.1. General	25
4.2. Specimen preparation (see appendix A4 for sampling for reinspection)	25
4.3. Test for Interior type bonded with interior glue	25
4.4. Tests for Interior type plywood bonded with intermediate glue	25
4.4.1. Preparation of test specimens	26
4.4.2. Vacuum-soak test	26
4.5. Tests for Exterior type and Interior type bonded with exterior glue (Exposure 1)	26
4.5.1. Preparation of test specimens	26-27
4.5.2. Vacuum-pressure test	27
4.5.3. Boiling test	27
4.5.4. Heat durability test	27
4.5.5. Tests for performance under concentrated static and impact loads	27
4.5.5.1. General	27
4.5.5.2. Specimen preparation	27
4.5.5.3. Test procedure	28
4.5.6. Test for performance under uniform loads	28
4.5.6.1. General	28
4.5.6.2. Equipment	28-29
4.5.6.3. Specimen preparation	29
4.5.6.4. Test procedure	29
4.5.7. Test for panel bending	29
4.5.7.1. General	29
4.5.7.2. Specimen preparation	29
4.5.7.3. Test procedure	29
4.6. Test for determination of moisture content (oven-drying method)	31

SECTION	PAGE
4.7. Scarf and finger joint tests	31
4.7.1. Scarf and finger joint strength	31-32
4.7.2. Scarf joint durability of Interior type panels bonded with interior glue	32
4.7.3. Scarf joint durability of Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or intermediate glue	32-33
4.7.4. Finger joint durability of Interior type panels bonded with interior glue	33
4.7.5. Finger joint durability of Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or intermediate type glue ..	33
5. Definitions	34-36
6. Grading and Certification	36
6.1. Certification of shipments	36
6.1.1. Qualified inspection and testing agency	37
6.2. Panel marking	37
6.2.1. Voiding marks	37
7. Effective date	37-38
8. History of Project	38
9. Standing Committee	38
Appendix	38
A1. Sizes and thicknesses	38
A1.1. Standard sizes	38
A1.2. Standard thicknesses	38
A2. Overlaid plywood	38
A3. Method of ordering	38-39
A4. Shipment reinspection practices	39
A4.1. General	39
A4.2. Responsibility of the buyer	39
A4.3. Responsibility of the seller	39
A4.4. Cost and assistance	39
A4.5. Reinspection procedures and settlement	39
A4.5.1. Condition of plywood	39
A4.5.2. Sampling for panel grade and thickness reinspections	40
A4.5.3. Plywood panel grade and thickness re- inspections	40
A4.5.4. Sampling for glue bond quality reinspections	40
A4.5.5. Plywood glue bond quality reinspections	40
A5. Metric conversion factors	40
APA Trademarks	42-43

Product Standard PS 1-83 For Construction and Industrial Plywood

Effective December 30, 1983. (See section 7.)

(This Standard, which was initiated by the American Plywood Association, has been developed under the *Procedures for the Development of Voluntary Product Standards* of the U.S. Department of Commerce as a revision of PS 1-74, *Construction and Industrial Plywood*.)

1. PURPOSE

The purpose of this Voluntary Product Standard is to establish nationally recognized requirements for the principal types and grades of construction and industrial plywood and to provide a basis for common understanding among producers, distributors, and users of the product.

2. SCOPE AND CLASSIFICATION

2.1. Scope—This Voluntary Product Standard covers the wood species, veneer grading, glue bonds, panel construction and workmanship, dimensions and tolerances, marking, moisture content, and packing of plywood intended for construction and industrial uses.¹ Also included are test methods to determine compliance, and a glossary of trade terms and definitions. A quality certification program is provided for herein, whereby qualified testing agencies inspect, sample, and test products identified as complying with this Standard. Information regarding generally available sizes, methods of ordering, and reinspecting practices, is provided in the appendix. As an aid in correlating U.S. customary units to metric units, conversion factors for the units used in this Standard are also given in the appendix.

¹Publications to provide purchasers of plywood with product end-use information are available from the American Plywood Association, P.O. Box 11700, Tacoma, WA 98411.

2.2. Classification—The plywood covered by this Standard is classified by exposure capability and grade.

2.2.1. Exposure capability—The plywood covered by this Standard is classified into two types, Interior and Exterior. Each type is a function of veneer grade and adhesive durability.

2.2.1.1. Interior type—Adhesive durability levels for Interior type plywood are as follows and are listed in increasing order of durability:

- (a) Bonded with interior glue. Plywood with this glue bond is intended for interior application. Adhesive performance requirements are provided in 3.7.1.
- (b) Bonded with intermediate glue. Plywood with this glue bond is intended for protected construction and industrial uses where moderate delays in providing protection may be expected or conditions of high humidity and water leakage may exist. Adhesive performance requirements are provided in 3.7.2.
- (c) Bonded with exterior (waterproof) glue identified as "Exposure 1" (see 3.8.6.4). Plywood with this glue bond is intended for protected construction and industrial uses where protection against moisture exposure due to long construction delays, or other conditions of similar severity, such as pressure preservative treating, is required. Adhesive performance requirements are provided in 3.7.3.

2.2.1.2. Exterior type—Exterior type plywood will retain its glue bond when repeatedly wetted and dried or otherwise subjected to the weather or to exposure of similar severity such as pressure preservative treating. It is, therefore, intended for permanent exterior exposure. Adhesive performance requirements are provided in 3.7.4.

2.2.2. Grade—Within each exposure capability type, there are a number of panel grades based on the grade of the veneers and the panel construction.

3. REQUIREMENTS

3.1. General—All plywood panels represented as conforming to this Standard shall meet or exceed all applicable requirements set forth herein. Test methods are given in Section 4. All terms shall be as defined in Section 5. Requirements for grademarking and certification shall be as given in Section 6.

3.2. Wood species

3.2.1. Species groups—For the purpose of this Standard, species shall be any softwood or hardwood species or trade groups listed in Table 1 and other species meeting the requirements of 3.2.3.

3.2.1.1. Species segregation—Species which cannot be distinguished in veneer form from similar species shall be classed as the largest numbered species group applicable (Group 4 is larger numbered than Group 1) unless the manufacturer provides valid evidence to the qualified inspection and testing agency that the species are properly segregated. Such segregation may be in the form of separation prior to peeling, mechanical testing for performance capability, or other recognized means.

3.2.2. Species for faces and backs—The species of face and back plies may be from any group listed in Table 1. When a face or back is made of more than one piece, the entire ply shall be of the same species. When outer layers consist of two or more plies, the outer or exposed plies are classified as faces (face plies) or backs (back plies) and the unexposed plies (sub-faces and sub-backs) are classified as inner plies, in terms of species requirements as provided in 3.2.3. Requirements for identification of all panels are given in 6.2.

3.2.3. Species for inner plies—Unless otherwise specified herein, inner plies of Groups 1, 2, 3 or 4 panels may be of any species listed in Groups 1, 2, 3 or 4 in Table 1. Inner plies of Group 5 panels may be of any species listed in Table 1. Unless otherwise specified herein, inner plies of all panels may also be of any softwood species or any hardwood species having a published average specific gravity value of 0.41 or more based on green volume and oven dry weight. The U.S. Forest Products Laboratory will be considered as final evaluator of published specific gravity data.

Table 1 Classification of Species

Group 1	Group 2		Group 3	Group 4	Group 5
Apitong ^{(a)(b)} Beech, American Birch Sweet Yellow Douglas Fir 1 ^(c) Kapur ^(a) Keruing ^{(a)(b)} Larch, Western Maple, Sugar Pine Caribbean Ocote Pine, Southern Loblolly Longleaf Shortleaf Slash Tanoak	Cedar, Port Orford Cypress Douglas Fir 2 ^(c) Fir Balsam California Red Grand Noble Pacific Silver White Hemlock, Western Lauan Almon Bagtikan Mayapis Red Lauan Tangle White Lauan	Maple, Black Mengkulang ^(a) Meranti, Red ^{(a)(d)} Mersawa ^(a) Pine Pond Red Virginia Western White Spruce Black Red Sitka Sweetgum Tamarack Yellow Poplar	Alder, Red Birch, Paper Cedar, Alaska Fir, Subalpine Hemlock, Eastern Maple, Bigleaf Pine Jack Lodgepole Ponderosa Spruce Redwood Spruce Engelmann White	Aspen Bigtooth Quaking Cativo Cedar Incense Western Red Cottonwood Eastern Black (Western Poplar) Pine Eastern White Sugar	Basswood Poplar, Balsam

(a) Each of these names represents a trade group of woods consisting of a number of closely related species.

(b) Species from the genus *Dipterocarpus* are marketed collectively: Apitong if originating in the Philippines; Keruing if originating in Malaysia or Indonesia.

(c) Douglas fir from trees grown in the states of Washington, Oregon, California, Idaho, Montana, Wyoming, and the Canadian Provinces of Alberta and British Columbia shall be classed as Douglas fir No. 1. Douglas fir from trees grown in the states of Nevada, Utah, Colorado, Arizona and New Mexico shall be classed as Douglas fir No. 2.

(d) Red Meranti shall be limited to species having a specific gravity of 0.41 or more based on green volume and oven dry weight.

3.3. Synthetic repairs

3.3.1. Synthetic fillers—Synthetic fillers shall be limited to the repair of minor defects as specified in this Standard. Synthetic fillers shall meet the requirements of the February 1981 edition of *Approval Procedures and Requirements for Synthetic Repairs*² published by the American Plywood Association.

3.3.2. Synthetic shims, patches and plugs—These repairs shall completely fill kerfs or voids; shall present a smooth, level surface; and shall not crack, shrink, or lose their bond. Performance of synthetic shims, patches, and plugs under normal conditions of service shall be comparable to that of wood repairs. The equivalency shall be established by testing and evaluation in accordance with the February 1981 edition of *Approval Procedures and Requirements for Synthetic Repairs*² published by the American Plywood Association.

3.4. Grade description of veneers—All veneers in the finished plywood panel shall conform to one of the grade requirements listed below. Unless otherwise stated, these requirements apply to 4 foot by 8 foot panels and are proportionate for other sizes. N grade is the highest classification.

3.4.1. Grade N veneer (intended for natural finish)

General

Grade N veneer shall be smoothly cut 100 percent heartwood or 100 percent sapwood, free from knots, knotholes, pitch pockets, open splits, other open defects, and stain.

—of not more than two pieces in 48 inch widths; not more than three pieces in wider panels.

—well matched for color and grain.

Synthetic fillers may be used to fill:

- (a) small cracks or checks not more than 1/32 inch wide.
- (b) small splits or openings up to 1/16 inch wide if not exceeding 2 inches in length.
- (c) small chipped areas or openings not more than 1/8 inch wide by 1/4 inch long.

Growth characteristics

Where pitch streaks occur, each shall average not more than 3/8 inch in width and shall blend with the color of the wood.

Repairs

Shall be wood, neatly made and parallel to grain.

—limited to a total of six in number.

—well matched for color and grain.

Patches shall be limited to three "router" patches not exceeding 1 inch in width and 3-1/2 inches in length. There shall be no overlapping.

Shims shall not exceed 3/16 inch in width or 12 inches in length and shall occur only at the ends of the panel.

3.4.2. Grade A veneer (suitable for painting)

General

Grade A veneer shall be firm; smoothly cut; and free of knots, pitch pockets, open splits, and other open defects

—well joined when of more than one piece.

Synthetic fillers may be used to fill:

- (a) In Exterior type panels: small cracks or checks not more than 1/32 inch wide; small splits or openings up to 1/16 inch wide, if not exceeding 2 inches in length; small chipped areas or openings not more than 1/8 inch wide by 1/4 inch long.
- (b) In Interior type panels: small cracks or checks not more than 3/16 inch wide; openings or depressions up to 1/2 inch wide by 2 inches long or equivalent area.

Growth characteristics

Where pitch streaks occur, each shall average not more than 3/8 inch in width and shall blend with the color of the wood. Sapwood and discolorations are permitted.

²American Plywood Association publications may be obtained by writing P.O. Box 11700, Tacoma, Washington 98411.

Repairs

Shall be wood or of synthetic patching material; neatly made and parallel to grain, limited to a total of 18 in number, excluding shims.

Patches

When of wood, shall be: "boat," "router," or "sled" type. Radius of ends of boat patches shall not exceed 1/8 inch.

Shall not be more than 2-1/4 inches in width singly.

Multiple wood repairs shall consist of not more than two patches, neither of which may exceed 7 inches in length if either is wider than 1 inch, except that, there may be one multiple repair consisting of three die-cut veneer patches.

Synthetic repairs shall not exceed 2-1/4 inches in width.

Shims are permitted, except that they shall not be used over or around patches or as multiple repairs.

3.4.3. Grade B veneer

Grade B veneer shall be solid and free from open defects and broken grain, except as permitted below. Slightly rough grain is permitted.

Minor sanding and patching defects, including sander skips, shall not exceed 5 percent of panel area.

Synthetic fillers may be used to fill:

- (a) In Exterior type panels: small splits or openings up to 1/16 inch wide if not exceeding 2 inches in length; small chipped areas or openings not more than 1/8 inch wide by 1/4 inch long.
- (b) In Interior type panels: small cracks or checks not more than 3/16 inch wide; openings or depressions up to 1/2 inch wide by 2 inches long or equivalent area.

Growth characteristics

Knots shall not exceed 1 inch measured across the grain and shall be both sound and tight.

Where pitch streaks occur, they shall average not more than 1 inch in width.

Discolorations are permitted.

Open defects

Splits shall not be wider than 1/32 inch.

Vertical holes shall not exceed 1/16 inch in diameter and shall not exceed an average of one per square foot in number.

Horizontal or surface tunnels shall be limited to 1/16 inch across, 1 inch in length, and to 12 in number.

Repairs

Shall be wood or synthetic patching material, neatly made.

Wood veneer repairs shall be die cut. Wood panel repairs shall be "router" or "sled" type.

Wood repairs shall not exceed 3 inches in width where occurring in multiple repairs, or 4 inches in width where occurring singly.

Synthetic veneer repairs shall not exceed 4 inches in width.

Synthetic panel repairs shall not exceed 2-1/4 inches in width.

Shims are permitted.

3.4.4. Grade C veneer

General

Sanding defects that will not impair the strength or serviceability of the panel are permitted.

Growth characteristics

Knots shall be tight and not more than 1-1/2 inches across the grain.

Discolorations are permitted.

Open defects

Knotholes shall not exceed 1 inch measured across the grain; except that, an occasional knothole more than 1 inch but not more than 1-1/2 inches measured across the grain, occurring in any section 12 inches along the grain is permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 6 inches in a 48 inch width, and proportionately for other widths.

Splits measured at a point 8 inches from the end of the panel shall not exceed 1/2 inch in width by 1/2 panel length or 3/8 inch in width by any panel length, provided separation at one end does not exceed 1/16 inch where split runs full panel length; however, the maximum width within 8 inches of the end of the panel (open end of split) shall not exceed the maximum width of knotholes permitted within the grade.

Splits on panel faces and backs shall not exceed 1/4 inch where located within 1 inch of parallel panel edge.

Voids due to missing wood on panel faces and backs not otherwise specified above shall not exceed the maximum width of knotholes permitted in the grade and the length of such voids shall not exceed 6 inches.

Wane not exceeding the size of permitted open defects is allowed, providing that where occurring at edges of veneer sheets, panel ply separation due to wane shall not exceed limit equivalent to that permitted for short and narrow inner plies in 3.8.3 for sanded panels, or 3.8.4 for unsanded or touch-sanded panels.

Repairs

Shall be wood or synthetic patching material, neatly made.

Wood veneer repairs shall be die cut. Wood panel repairs shall be "router" or "sled" type.

Wood repairs shall not exceed 3 inches in width where occurring in multiple repairs, or 4 inches in width where occurring singly.

Synthetic veneer repairs shall not exceed 4 inches in width.

Synthetic panel repairs shall not exceed 2-1/4 inches in width.

Shims are permitted.

3.4.4.1. C Plugged veneer—This veneer may contain knotholes, worm and borer holes, and other open defects not larger than 1/4 inch by 1/2 inch; sound and tight knots up to 1-1/2 inches measured across the grain; splits up to 1/8 inch wide; broken grain; pitch pockets, if solid and tight; plugs; patches, and shims. Synthetic repairs in veneer shall not exceed 4 inches in width. Synthetic panel repairs shall not exceed 2-1/4 inches in width. Where grades having C Plugged face veneer are identified as fully sanded, sanding defects shall be the same as admitted under B grade. Sander skips to any degree shall be admissible in touch-sanded C Plugged veneer.

3.4.5. Grade D veneer

General

Except as otherwise required herein, any number of plugs, patches, shims, worm or borer holes, sanding defects, and other characteristics shall be permitted, provided they do not seriously impair the strength or serviceability of the panels.

Growth characteristics

Tight knots in inner plies shall be permitted.

In D grade backs, knots shall be tight and not larger than 2-1/2 inches across the grain except that an occasional tight knot larger than 2-1/2 inches but not larger than 3 inches measured across the grain, occurring in any section 12 inches along the grain is permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 10 inches in a 48 inch width and proportionately for other widths.

Open defects

Knotholes shall not exceed 2-1/2 inches across the grain, except that an occasional knothole larger than 2-1/2 inches but not larger than 3 inches across the grain occurring in any section 12 inches along the grain is permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 10 inches in a 48 inch width, and proportionately for other widths.

Knotholes in sanded panels shall not exceed 2-1/2 inches across the grain in veneer thicker than 1/8 inch.

Knotholes shall not exceed 3-1/2 inches across the grain in veneers at least two plies removed from the face or back plies of C-D and C-D Plugged grades having five or more plies.

Splits measured at a point 8 inches from the end of the panel shall not exceed 1 inch in width, tapering to not more than 1/16 inch where split runs full panel length; however, the maximum width within 8 inches of the end of the panel (open end of split) shall not exceed the maximum width of knotholes permitted within the grade.

Splits on panel faces and backs shall not exceed 1/4 inch where located within 1 inch of parallel panel edge.

Voids due to missing wood on panel backs not otherwise specified above shall not exceed the maximum width of knotholes permitted in the grade and the length of such voids shall not exceed 6 inches.

Wane not exceeding the size of permitted open defects is allowed, providing that where occurring at edges of veneer sheets, panel ply separation due to wane shall not exceed limit equivalent to that permitted for short and narrow inner plies in 3.8.3 for sanded panels, or 3.8.4 for unsanded or touch-sanded panels.

White pocket

Any area 24 inches wide across the grain and 12 inches long, in which light or heavy white pocket occurs, shall not contain more than three of the following characteristics, in any combination:

- (a) 6 inch width of heavy white pocket.
- (b) 12 inch width of light white pocket.
- (c) One knot or knothole, 1-1/2 inches to 2-1/2 inches, or two knots or knotholes, 1 inch to 1-1/2 inches; knots or knotholes less than 1 inch shall not be considered. Sizes of any knot or knothole shall be measured across the grain. Any repair in a white pocket area shall be considered for grading purposes as a knothole.

3.5. Veneers and layers

3.5.1. Veneer thickness—Except as provided for below, veneer shall be 1/10 inch or thicker in panels 3/8 inch rough (unsanded) thickness or over; 1/12 inch or thicker in panels of less than 3/8 inch rough (unsanded) thickness. In no case shall veneers used in face or back layers be thicker than 1/4 inch, or veneers used in inner layers thicker than 5/16 inch.

One-twelfth-inch veneer may be used as crossbands in 5-ply, 5-layer, 1/2 inch panels and in parallel laminated layers as provided for in 3.5.2.

One-sixteenth-inch veneer may be used: for any ply in 5-ply, Exterior type panels less than 1/2 inch in thickness; as the center only in other 5-ply panels; and may be included in a parallel laminated layer as provided for in 3.5.2.

Face and back veneers must be 1/8 inch minimum thickness for 19/32 inch and 5/8 inch, 3-, 4-, and 5-ply, 3-layer panels of C-D, C-D Plugged, C-C, C-C Plugged and Underlayment grades.

For further limitations on panel layup, refer to 3.8, Panel Constructions and Workmanship.

The average veneer thickness shall conform to the limitations given in this Standard within a tolerance of ± 5 percent of the specified nominal thickness measured dry before layup.

3.5.2. Parallel laminated layers—Parallel laminated outer layers may be used only in C-C, C-D, Structural I C-C and C-D, and Structural II C-C and C-D grades. Such layers shall consist of veneers 1/10 inch or thicker in any combination not exceeding 1/4 inch total layer thickness. The face and back plies or exposed plies of outer layers shall conform to the species group and grade requirements for faces and backs, respectively, of the panel grade. The unexposed plies of outer layers, or sub-face and sub-back plies, shall conform to the species group and grade requirements for inner plies of the panel grade as specified in Tables 2 and 3 and 3.6.5. The maximum split or gap in sub-faces and sub-backs shall be 1/4 inch under the faces of Structural I C-C and C-D and Structural II C-C and C-D panels; 1/2 inch under the faces of C-C and C-D grades, and 1/2 inch under D backs.

Parallel laminated inner layers in any grade shall consist of veneers 1/16 inch or thicker in any thickness combination not exceeding 7/16 inch total layer thickness. Individual plies in such layers shall conform to the species group and grade requirements for inner plies of the panel grade.

3.5.3. Scarfed veneers—Scarfed veneers may be used for any face, back, or inner ply except as provided in 3.9. Scarfed joints shall not have a slope steeper than 1 to 8. Veneer in the scarf area shall not contain defects which reduce its effective cross section by more than 20 percent. Veneer scarfed joints shall be glued with a waterproof adhesive.

3.6. Panel grades—The standard combination of the veneers in 3.4 into the various panel grades shall be as provided in Tables 2 and 3, with the additional requirements given below. The grain direction of the outer layers shall be either parallel or perpendicular to the long dimension of the panel.

3.6.1. Marine—Marine grades shall meet the requirements of Exterior type and shall be of one of the following grades: A-A, A-B, B-B, High Density Overlay, or Medium Density Overlay, all as modified below.

Only Douglas Fir 1 and Western Larch veneers shall be used.

VENEERS—“A” faces shall be limited to a total of nine single repairs in a 4-foot by 8-foot sheet, or to a proportionate number in any other size as manufactured.

All inner plies shall be B grade or better and shall be full length and width.

All wood repairs shall be glued with an adhesive meeting the Exterior type performance requirements of 3.7.4 and, in addition, shall be set in the panel using a technique involving both heat and pressure.

When the inner plies consist of two or more pieces of veneer, the edges shall be straight and square, and shall not overlap.

CROSSBAND GAPS AND EDGE SPLITS—Neither edge of a panel shall have any crossband gap or edge split in excess of 1/8 inch wide. Crossband gaps and edge splits per 8 feet of crossband ply shall not exceed four in number. End splits and gaps on either end of a panel shall not exceed 1/8 inch in aggregate width.

There shall be no filling of crossband gaps and edge splits.

Table 2. Interior Type Grades

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
N-N	N	N	C	Sanded 2 sides
N-A	N	A	C	Sanded 2 sides
N-B	N	B	C	Sanded 2 sides
N-D	N	D	D	Sanded 2 sides
A-A	A	A	D	Sanded 2 sides
A-B	A	B	D	Sanded 2 sides
A-D	A	D	D	Sanded 2 sides
B-B	B	B	D	Sanded 2 sides
B-D	B	D	D	Sanded 2 sides
Underlayment ^(a)	C Plugged	D	C & D	Touch-sanded
C-D Plugged	C Plugged	D	D	Touch-sanded
Structural I C-D		See 3.6.5		Unsanded ^(b)
Structural I C-D Plugged, Underlayment		See 3.6.5		Touch-sanded
Structural II C-D		See 3.6.5		Unsanded ^(b)
Structural II C-D Plugged, Underlayment		See 3.6.5		Touch-sanded
C-D	C	D	D	Unsanded ^(b)
C-D with exterior glue (See para. 3.6.6)	C	D	D	Unsanded ^(b)

(a) See 3.6.3 and Table 5 for special limitations.

(b) See 3.8.4 for requirements.

3.6.2. Decorative panels—Specialty panels with decorative face and veneer treatments which except for the special face treatment, meet all of the requirements of this Standard, including veneer qualities, glue bond performance and workmanship, shall be considered as conforming to this Standard. All grades in Tables 2 and 3 may be manufactured as decorative grades.

An occasional butt joint up to 6 inches in width shall be permitted for decorative effect in veneer on one panel face only. Where butt joints occur, the aggregate width of all knots and knotholes and two-thirds the aggregate width of all repairs, including butt joints, shall not exceed 6 inches in any area 12 inches along the grain by 48 inches wide or proportionately for other widths.

3.6.3. Underlayment, C-C Plugged—Face veneer shall be 1/10 inch or thicker before sanding. The veneer immediately adjacent to the face ply of C-C Plugged and Underlayment shall be C grade or better with no knotholes over 1 inch across the grain; except that, (1) veneer immediately adjacent to the face

ply of Underlayment may be D grade with open defects up to 2-1/2 inches across the grain or (2) veneer immediately adjacent to the face ply of C-C Plugged may be C grade with open defects up to 1-1/2 inches across the grain, provided the face veneer is of Group 1 or 2 species of 1/6 inch minimum thickness before sanding. Also see Table 5 requirements.

3.6.4. B-B concrete form panels—Face veneers shall not be less than B grade and shall always be from the same species group. Inner plies shall be not less than "C" grade. This grade of plywood is produced in two classes and panels of each class shall be identified accordingly. Panels shall be sanded two sides and mill-oiled unless otherwise agreed upon between buyer and seller. Species shall be limited as follows and are applicable also to High Density Overlay Exterior concrete form panels:

Class I—Faces of any Group 1 species, crossband of any Group 1 or Group 2 species, and centers of any Group 1, 2, 3, or 4 species.

Table 3. Exterior Type Grades^(a)

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
Marine, A-A, A-B, B-B, HDO, MDO		See 3.6.1		See regular grades
Special Exterior, A-A, A-B, B-B, HDO, MDO		See 3.6.7		See regular grades
A-A	A	A	C	Sanded 2 sides
A-B	A	B	C	Sanded 2 sides
A-C	A	C	C	Sanded 2 sides
B-B (concrete form)		See 3.6.4		—
B-B	B	B	C	Sanded 2 sides
B-C	B	C	C	Sanded 2 sides
C-C Plugged ^(b)	C Plugged	C	C	Touch-sanded
C-C	C	C	C	Unsanded ^(c)
A-A High Density Overlay	A	A	C Plugged	—
B-B High Density Overlay	B	B	C Plugged ^(d)	—
B-B High Density Concrete Form Overlay (See para. 3.6.4)	B	B	C Plugged	—
B-B Medium Density Overlay	B	B	C	—
Special Overlays	C	C	C	—

(a) Available also in Structural I and Structural II classifications as provided in paragraph 3.6.5.

(b) See 3.6.3 and Table 5 for special limitations.

(c) See 3.8.4 for requirements.

(d) C centers may be used in panels of five or more plies.

Class II—Faces of any Group 1 or Group 2 species, and crossband and centers of any Group 1, 2, 3, or 4 species, or, faces of Group 3 species of 1/8 inch minimum thickness before sanding, crossband of any Group 1, 2, or 3 species, and centers of any Group 1, 2, 3, or 4 species.

3.6.5. Structural panels—These panels are especially designed for engineered applications such as structural components where design properties, including tension, compression, shear, cross-panel flexural properties and nail bearing may be of significant importance. In addition to the special species, grade and glue bond requirements set forth below, structural panels shall meet all other requirements in this Standard for the applicable types and grades.

Grade	Glue Bond	Species
Structural I C-D ^(a) C-D Plugged ^(a) Underlayment ^(a)	Shall meet the requirements of 3.7.3	Face, and back and all inner plies limited to Group 1 species
Structural II C-D ^(a) C-D Plugged ^(a) Underlayment ^(a)	Shall meet the requirements of 3.7.3	Face, back and all inner plies may be of any Group 1, 2, or 3 species
Structural I All Exterior grades (see Table 3)	Exterior	Face, back and all inner plies limited to Group 1 species
Structural II All Exterior grades (see Table 3)	Exterior	Face, back and all inner plies may be of any Group 1, 2, or 3 species

(a) Special limitations applying to Structural (C-D, C-D Plugged, Underlayment) grade panels are:

- In D grade veneers white pocket in any area larger than the size of the largest knothole, pitch pocket or split specifically permitted in D grade shall not be permitted in any ply.
- Sound tight knots in D grade shall not exceed 2-1/2 inches measured across the grain, except as provided in Table 5.
- Plugs, including multiple repairs, shall not exceed 4 inches in width.
- Panel construction shall be as specified in 3.8.

3.6.6. Interior type bonded with exterior glue (Exposure 1)—Regular Interior plywood bonded to meet the requirements of 3.7.3.

3.6.7. Special Exterior—An Exterior type panel that may be produced of any species covered by this Standard. Except in regard to species, it shall meet all of the requirements for Marine panels (see 3.6.1) and be produced in one of the following grades: A-A, A-B, B-B, High Density Overlay, or Medium Density Overlay.

3.6.8. Overlays—For overlaid plywood, the grade designation for face and back, as given in Table 3, refers to the veneer directly underlying the surface. All overlaid plywood shall be overlaid on two sides unless otherwise agreed to between buyer and seller. When only one side is overlaid, the exposed back shall be C or better.

3.6.8.1. High Density Overlay—The standard grades of High Density Overlay shall be as listed in Table 3. The surface of the finished product shall be hard, smooth, or uniformly textured, although some evidence of underlying grain may appear. The surface shall be of such a character that further finishing by paint or protective coating is not necessary. Although the common resin type employed in HDO is phenol, other resin systems that meet the requirements stated below may be used. A phenolic resin-based overlay system shall consist of a cellulose-fiber sheet or sheets, containing not less than 45 percent resin solids, based on the volatile-free weight of fiber and resin exclusive of glue. The total resin-impregnated materials for each face, exclusive of glue, shall be not less than 0.012 inch thick before pressing and shall weigh not less than 60 pounds per 1,000 square feet in the ready-to-use condition. The bond of the overlay system to the plywood shall be continuous and without voids or blisters. Other resin-cellulose fiber overlay systems having a weight of not less than 60 pounds per 1,000 square feet of single surface, exclusive of glue, and which possess performance capabilities of the above phenol system, may be identified as High Density Overlay. Determination of equivalent performance shall be based on tests described in *Test Methods for PS 1 Overlays*³ published by the American Plywood Association, February 1981.

3.6.8.2. Medium Density Overlay—The standard grade of Medium Density Overlay shall be as listed in Table 3. The resin-treated facing on the finished product shall present a smooth, uniform or uniformly textured surface intended for high-quality paint finishes. Some evidence of underlying grain may appear. Although the characteristic resin type employed is phenol, other resin systems that meet the requirements stated below may be used. The typical thermosetting phenolic resin system shall consist of a cellulose-fiber sheet or sheets containing not less than 17 percent resin solids for a beater-loaded sheet, or 22 percent for an impregnated sheet, both based on the volatile-free weight of resin and fiber,

³See footnote 2 on page 8.

exclusive of glueline. The resin-treated material shall weigh not less than 58 pounds per 1,000 square feet of single face, including both resin and fiber, but exclusive of glueline. After application, the material shall measure not less than 0.012 inch thick. Other resin-cellulose fiber overlay systems having a weight of 58 or more pounds per 1,000 square feet of single surface exclusive of glueline, and which possess performance capabilities of the above phenol system, may be identified as Medium Density Overlay. Determination of equivalent performance shall be based on tests described in *Test Methods for PS 1 Overlays*⁴ published by the American Plywood Association, February 1981.

3.6.8.3. Special overlays—These are surfacing materials having special characteristics which do not fit the particular description of High Density or Medium Density types as given in 3.6.8.1 and 3.6.8.2 and which shall consist in significant part of resin-treated fiber. The surfacing materials shall meet the glue bond requirements for overlaid plywood. Although designed for a wide variety of uses, this overlaid plywood shall be Exterior type, including the base panel, bond of overlay to the panel, and the overlay itself. Panels shall be identified as "Special Overlay."

3.7. Adhesive bond requirements for a panel or a lot

General

Any adhesive or bonding system that causes degradation of the wood or latent failure of bond shall not be used.

3.7.1 Interior type bonded with interior glue—A panel shall be considered as meeting the requirements of this Standard if three or more of the five test specimens pass when tested in accordance with 4.3. Panels from lots shall be evaluated for conformance with this Standard in the following manner:

Underlayment, C-D Plugged, and C-D:

A panel shall be classed as failing if more than two of the five test specimens fail. The material represented by the sampling shall be considered as meeting the requirements of this Standard if 90 percent or more of the panels pass the test described in 4.3.

All Other Grades:

A panel shall be classed as failing if more than two of the five test specimens fail. The material represented by the sampling shall be considered as meeting the requirements of this Standard if 85 percent or more of the panels pass, when tested in accordance with 4.3.

3.7.1.1. Mold resistance: Underlayment, C-D Plugged and C-D—These grades shall be made with an adhesive possessing a mold resistance equivalent to that created by adding, to plain protein glue, five pounds of pentachlorophenol or its sodium salt per 100 pounds of dry glue base. The equivalency shall be established by testing and evaluation in accordance with *Mold Testing Procedures and Approval Requirements*⁴ published by the American Plywood Association, April 9, 1964 (this procedure is specifically designed for adhesive qualification approval and is not applicable to inspection and testing, as covered in Section 4).

3.7.1.2. Resistance to elevated temperature: Underlayment, C-D Plugged and C-D—These grades shall be made with an adhesive possessing resistance to temperatures up to 160°F at least equal to that of plain protein glue. Urea resin glue shall not be used in these grades unless evidence is submitted indicating performance equivalent to that of plain protein glue.

3.7.2. Interior type bonded with intermediate glue—A panel of Interior plywood bonded with intermediate glue shall be considered as meeting the requirements of this Standard if the test specimens taken from a panel average 45 percent wood failure or more when tested in accordance with 4.4.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if both of the following minimum requirements are met:

1. The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 45 percent.
2. When more than one panel is tested, at least 90 percent of the panels represented by the test pieces shall have 30 percent wood failure or better.

⁴See footnote 2 on page 8.

Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 1/8 inch deep and 1 inch long shall be rated as zero (0) percent wood failure.

3.7.2.1. Intermediate glue heat durability—Requirements shall be the same as for exterior glue (see 3.7.4.1).

3.7.2.2. Bacteria-mold resistance—Adhesives, in order to qualify as intermediate glue, shall meet the *Bacteria Test* requirements as published by the American Plywood Association, August 13, 1968⁵. This procedure is specifically designed for adhesive qualification and is not applicable to inspection and testing, as covered in Section 4.

3.7.3. Interior type bonded with exterior glue (Exposure 1)—A panel of Interior plywood bonded with exterior glue (Exposure 1) shall be considered as meeting the requirements of this Standard if the test specimens taken from a panel average 80 percent wood failure or greater when tested in accordance with 4.5.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if all of the following minimum requirements are met:

1. The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 80 percent.
2. When more than one panel is tested:
 - a. at least 90 percent of the panels represented by the test pieces shall have 60 percent wood failure or better.
 - b. at least 95 percent of the panels represented by the test pieces shall have 30 percent wood failure or better.

The above requirements are applicable separately and independently to the results obtained from the vacuum-pressure test and the boiling test as given in Section 4. Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 1/8 inch deep and 1 inch long shall be rated as zero (0) percent wood failure.

3.7.3.1. Interior type bonded with exterior glue (Exposure 1): heat durability—Panels shall meet the heat durability requirements for exterior glue (see 3.7.4.1).

3.7.4. Exterior type—When tested in accordance with 4.5, Exterior type plywood shall be considered as meeting the requirements of this Standard if the test specimens taken from a panel average 85 percent wood failure or greater.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if all of the following minimum requirements are met:

1. The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 85 percent.
2. When more than one panel is tested:
 - a. at least 75 percent of the panels represented by the test pieces shall have 80 percent wood failure or better.
 - b. at least 90 percent of the panels represented by the test pieces shall have 60 percent wood failure or better.
 - c. at least 95 percent of the panels represented by the test pieces shall have 30 percent wood failure or better.

The above requirements are applicable separately and independently to the results obtained from the vacuum-pressure test and the boiling test as given in Section 4. Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 1/8 inch deep and 1 inch long shall be rated as zero (0) percent wood failure.

3.7.4.1. Exterior glue heat durability—Exterior type plywood shall be considered as meeting the requirements of this Standard if there is no delamination in any specimen, except when occurring at a localized defect permitted in the grade, when tested in accordance with 4.5.4. When testing overlaid plywood, blisters or bubbles in the surface caused by combustion shall not be considered as delamination.

3.7.4.2. Overlaid plywood—The bond between veneers of overlaid plywood as well as the bond between the overlay and the base panel shall meet the wood failure requirements described above for Exterior type plywood. In evaluating specimens for separation of the resin-treated face from the plywood, fiber failure shall be considered the same as wood failure.

⁵See footnote 2 on page 8.

3.8. Panel constructions and workmanship—Constructions for all panels shall conform to the minimum number of plies and layers as set forth in Table 4. The proportion of wood with grain perpendicular to panel face grain shall be not less than 33 percent nor more than 70 percent of the total panel thickness. The combined thickness of inner layers in panels having 4 or more plies shall be not less than 45 percent of the total panel thickness. For application of the above requirements, the panel thickness shall be the actual finished panel thickness and the veneer thickness shall be the dry veneer thickness before layup. The grain of all layers shall be perpendicular to the grain of adjacent layers and to the ends or edges of the panel. The entire area of each contacting surface of the adjacent plies, including repairs, shall be bonded with an adhesive in a manner to assure compliance with the performance requirements

for its type as set forth in the test described in Section 4. For the purpose of veneer repairing or edge joining, strings, ribbons, or tapes up to 3/8 inch maximum width can occur in a glueline and shall be considered as allowable localized defects in the evaluation of glueline test specimens. Wider strings, ribbons, or tapes may be used for veneer repairing or joining if they are pre-qualified to show bonding equal to the required bonding for the panel. Glueline test specimens cut to include the strings, ribbons, or tapes wider than 3/8 inch shall not be discarded because of the presence of these materials.

Veneer strips may be joined by string stitching provided the punch for making holes prior to stitching has a dimension across the grain of 0.095 inch or less and the holes are spaced 1/2 inch center-to-center or greater. All veneer used for inner plies may

Table 4. Panel Constructions

Panel Grades	Finished Panel Nominal Thickness Range (Inch)	Minimum Number of Plies	Minimum Number of Layers
Exterior Marine Special Exterior (See para. 3.6.7) B-B concrete form High Density Overlay High Density concrete form overlay	Through 3/8 Over 3/8, through 3/4 Over 3/4	3 5 7	3 5 7
Interior N-N, N-A, N-B, N-D, A-A, A-B, A-D, B-B, B-D Structural I (C-D, C-D Plugged and Underlayment) Structural II (C-D, C-D Plugged and Underlayment) Exterior A-A, A-B, A-C, B-B, B-C Structural I and Structural II (C-C and C-C Plugged) (See para. 3.6.5) Medium Density and special overlays	Through 3/8 Over 3/8, through 1/2 Over 1/2, through 7/8 Over 7/8	3 4 5 6	3 3 5 5
Interior (Including grades with exterior glue) Underlayment Exterior C-C Plugged	Through 1/2 Over 1/2, through 3/4 Over 3/4	3 4 5	3 3 5
Interior (Including grades with exterior glue) C-D C-D Plugged Exterior C-C	Through 5/8 Over 5/8, through 3/4 Over 3/4	3 4 5	3 3 5

be stitched. Stitched veneer used for outer plies is limited to panels with C or D grade faces or backs, except stitched C veneer may not be used for faces in Decorative panels. Panels may have face or back plies stitched but not both.

Rough or unsanded plywood may have paper tape on either face or back, or both; except that, in C-C Exterior, no tape used for veneer splicing shall be permitted.

Shims or strips of veneer shall not be used to repair panel edge voids. However, filling of permissible edge voids with synthetic fillers neatly applied will be allowed, except as prohibited in Marine grades (see 3.6.1). Staples or pins of metal or synthetic material are prohibited.

Where face or back plies consist of more than one piece of edge joined veneer, gaps between adjacent pieces shall be graded as splits.

End butt joints may be used only under the following conditions:

(a) Decorative grades as provided in 3.6.2.

(b) Butt joints having a total aggregate width not exceeding the width of the panel may occur in the center ply of 5-ply, 5-layer panels. The butt joints must be perpendicular to the grain of the panel face and back plies. The use of butt-jointed centers is allowed in Interior sanded grades in thicknesses up to and including 1/2 inch, and in C-D and C-D Plugged thicknesses up to and including 3/4 inch. End butt joints shall not be used in Structural I or II panels. Panels with butt joints in center plies shall be marked "butt-jointed center" as specified in 6.2.

Plywood shall be clean and free from blisters, laps and other defects, except as expressly permitted herein. Panels shall have no continuous holes or through openings from face to back.

3.8.1. Crossband gaps and center gaps—Crossband gaps or center gaps, except as noted for plugged crossband and jointed crossband, shall not exceed 1 inch in width for a depth of 8 inches (measured from panel edge). The average of all gaps occurring in a panel shall not exceed 1/2 inch. Where inner layers are thicker than 1/4 inch, gaps in the laminated plies shall be offset 1 inch if over 1/4 inch wide.

Where plugged inner plies are specified, inner plies shall be of C Plugged veneer and gaps between adjacent pieces of inner plies shall not exceed 1/2 inch.

Where jointed inner plies are specified, gaps between pieces of inner plies shall not exceed 3/8 inch, and the average of all gaps occurring in a panel shall not exceed 3/16 inch.

3.8.2. Veneer requirements—The veneers used in each ply of each panel and the completed panel shall conform with the applicable veneer grade and with the construction and workmanship requirements given herein. Additionally, in recognition of the requirements of selected end uses, the type and frequency of specific characteristics shall be further limited for grades in Table 5.

3.8.3. Sanded panels—Unless otherwise specified, sanded plywood shall be sanded on two sides. Sanding defects for N, A, B, and C Plugged faces shall be as given in 3.4. Exposed N, A, and B veneer surfaces of panels shall have the bark or tight surface out. Plies directly under the surface of overlaid panels are not considered exposed veneers. Faces and backs of panels shall be full width and full length; except that, C grade and D grade backs may be narrow on one edge or short on one end only, but by not more than 1/8 inch for half the panel length or width. Inner plies shall be full width and length; except that, panels other than Marine, may have one edge or end void not exceeding 1/8 inch in depth and 8 inches in length per panel. Except as otherwise specified in Table 5 for specific panel grade designations, crossband veneers not exceeding 1/8 inch in thickness may be lapped but by not more than 3/16 inch when adjacent to faces, or 1/2 inch when adjacent to backs, and provided such laps create no adjacent visible openings. Sanding defects resulting from crossband laps shall not be permitted in panel faces.

Table 5. Characteristics Prohibited or Restricted in Certain Panel Grades

Panel Grade Designation	Description and Number of Characteristics Per Panel
N-N, N-A	No crossband laps adjacent to faces and backs
N-B	No crossband laps adjacent to N faces No more than 2 crossband laps adjacent to B grade side (3.8.3) Laps are limited to 3/16 inch
N-D	No crossband laps adjacent to faces No more than a total of 2 of any combination of the following: — Knothole in D veneer over 2-1/2 inches but not over 3 inches — Split in D veneer over 1/2 inch (not over 1 inch) — Crossband lap adjacent to backs
Underlayment and C-C Plugged	No knotholes in veneer adjacent to face over 1 inch across the grain where C grade is required per tables 2 and 3 No knotholes in veneer adjacent to face over 2-1/2 inches where D grade is permitted or over 1-1/2 inches where C grade is permitted per 3.6.3 No laps adjacent to face
Structural I and II C-D	No splits in faces over 1/4 inch No splits in backs over 1/2 inch No more than a total of 2 of any combination of the following: — Knothole in C veneer over 1 inch but not over 1-1/2 inches — Knot in D backs over 2-1/2 inches but not over 3 inches — Knothole in D veneer over 2-1/2 inches but not over 3 inches — Crossband lap adjacent to faces (See 3.8.4) — Crossband lap adjacent to backs (See 3.8.4)
Structural I and II C-D Plugged	No splits in backs over 1/2 inch No more than a total of 2 of any combination of the following: — Knot in D backs over 2-1/2 inches but not over 3 inches — Knothole in D veneer over 2-1/2 inches but not over 3 inches — Crossband lap adjacent to faces (See 3.8.4) — Crossband lap adjacent to backs (See 3.8.4)
Structural I and II Underlayment	No knotholes in core veneer next to face over 1 inch No crossband laps adjacent to faces No splits in backs over 1/2 inch No more than a total of 2 of any combination of the following: — Knot in D backs over 2-1/2 inches but not over 3 inches — Knothole in D veneer over 2-1/2 inches but not over 3 inches — Crossband lap adjacent to backs (See 3.8.3, 3.8.4)

3.8.4. Unsanded and touch-sanded panels—C or D grade veneers may be lapped by not more than 1/2 inch provided such laps create no adjacent visible opening. Additional limitations on laps adjacent to panel faces and backs are included in Table 5. All plies of C-D panels shall be full length and full width; except that, no more than half the length of one edge nor half the width of one end may contain short or narrow plies, provided:

- (a) Such plies shall not be short or narrow by more than 3/16 inch; except that, crossbands may be short by 1/2 inch and centers may be narrow by 1/2 inch provided they taper to within 3/16 inch or less of the panel edge in 8 inches.

- (b) When short or narrow by more than 3/16 inch, the aggregate area in the plane of the plies of such edge characteristics shall not exceed 6 square inches in the entire panel.

- (c) Such edge characteristics shall not occur in more than one ply at any panel cross section.

In grades other than C-D, backs may be narrow on one edge or short on one end only, but by not more than 1/8 inch for half the panel length or width; inner plies shall be full width and length; except that, one edge or end void not exceeding 1/8 inch in depth and 8 inches in length per panel, shall be acceptable.

Panels manufactured as C-C, C-D, Structural C-C and Structural C-D shall not be sanded, touch-sanded, surface textured, or thickness sized by any mechanical means. However, sanded or touch-sanded panels which do not meet the grades for which they were intended may be reclassified and

marked as C-C or C-D, provided the panels meet all applicable requirements for C-C or C-D and the finished face and back veneers after sanding each have a minimum net thickness equal to 90 percent of the applicable thickness in Table 6.

Table 6. Span Ratings for Sheathing and Single-Floor Panels.

(For special ply-layer and species requirements applicable to STRUCTURAL panels, see Section 3.6.5 and Table 4. For crossband and total inner ply thickness proportion requirements, see Section 3.8).

Span Rating ^(a)	Nominal Panel Thickness (in.)	Minimum Number of Plys- Layers	Minimum Face & Back Veneer Thickness Before Pressing, for Species Group ^(b) (in.)				Inner Ply Species Group
			1	2	3	4	
Sheathing Panels (C-D, C-C)							
12/0	5/16	3-3	1/12	1/12	1/12	1/12	1, 2, 3 or 4
16/0	5/16	3-3	1/12	1/12	1/12	(c)	1, 2, 3 or 4
	11/32	3-3	1/12	1/12	1/12	1/12	1, 2, 3 or 4
20/0	5/16	3-3	1/12	(c)	(c)	(c)	1, 2, 3 or 4
	11/32	3-3	1/12	1/12	1/10	(c)	1, 2, 3 or 4
	3/8	3-3	1/10	1/10	1/10	1/10	1, 2, 3 or 4
24/0	3/8	3-3	1/10	(c)	(c)	(c)	1, 2, 3 or 4
	13/32	3-3	1/10	1/10	(c)	(c)	1, 2, 3 or 4
	1/2	3-3	1/10	1/10	1/10	1/10	1, 2, 3 or 4
32/16	1/2	3-3	1/10	1/6	(c)	(c)	1, 2, 3 or 4
	17/32	3-3	1/10	1/10	1/6	(c)	1, 2, 3 or 4
	5/8	3-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
40/20	5/8	3-3	(d)	1/6	(c)	(c)	1, 2, 3 or 4
	21/32	3-3	1/10	1/8	1/6	(c)	1, 2, 3 or 4
	3/4	4-3	1/10	1/10	1/10	1/8	1, 2, 3 or 4
	25/32	4-3	1/10	1/10	1/10	1/10	1, 2, 3 or 4
48/24	3/4	4-3	1/10	1/6	(c)	(c)	1, 2, 3 or 4
	25/32	4-3	1/10	1/8	1/6	(c)	1, 2, 3 or 4
	7/8	5-5	1/10	1/10	1/10	(c)	1, 2, 3 or 4
	29/32	5-5	1/10	1/10	1/10	1/8	1, 2, 3 or 4
Single-Floor Panels (UNDERLAYMENT, C-C Plugged)							
16 o.c.	1/2	3-3	1/10	(c)	(c)	(c)	1, 2, 3 or 4
	19/32	4-3	(d)	(d)	(d)	1/6	1, 2, 3 or 4
	5/8	4-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
20 o.c.	19/32	4-3	(d)	1/6	(c)	(c)	1, 2, 3 or 4
	5/8	4-3	(d)	1/8	1/6	(c)	1, 2, 3 or 4
	23/32	4-3	1/10	1/10	1/10	1/8	1, 2, 3 or 4
	3/4	4-3	1/10	1/10	1/10	1/10	1, 2, 3 or 4
24 o.c.	23/32	4-3	1/10	1/6	3/16	(c)	1, 2, 3 or 4
	3/4	4-3	1/10	1/8	1/6	(c)	1, 2, 3 or 4
	7/8	5-5	1/10	1/10	1/10	1/8	1, 2, 3 or 4
48 o.c.	1-1/8	7-5	1/8	1/6	(c)	(c)	1 or 2
	1-1/8	7-5	1/7	1/6	(c)	(c)	1, 2 or 3
	1-1/8	7-7	1/10	1/6	3/16	(c)	1
	1-1/8	7-7	1/8	1/6	3/16	(c)	1, 2 or 3

(a) See 3.8.5 for description.

(b) Intermixing between species groups and/or thicknesses in the faces and backs of panels is permitted. Use the lowest applicable Span Rating to identify the panel. Also see 3.5.1.

(c) Not permitted.

(d) 1/8-inch minimum for 3, 4 and 5-ply 3-layer panels per 3.5.1. May be 1/10 minimum for 5-ply 5-layer panels.

3.8.5. Span ratings for unsanded and touch-sanded panels—Grade-trademarking of C-C, C-D, Structural C-C, Structural C-D, and of C-C Plugged and Underlayment to be used as combination subfloor-underlayment (single floor) shall include a "Span Rating." The numbers are presented as a fraction in the marking of sheathing grades of plywood, and as a single number for C-C Plugged and Underlayment. They describe the recommended maximum spans in inches under normal use conditions and are in accordance with commonly accepted criteria. Panels for which there is no Span Rating shall be identified by largest species group number of the face and back, or by the Span Rating of the next thinner comparable panel. Sheathing panels manufactured 1/32 inch over standard thickness may be identified as the standard thickness.

For sheathing, the left-hand number refers to spacing of roof framing, and the right-hand number relates to spacing of the floor framing. The single number for Underlayment and C-C Plugged refers to spacing of the floor framing in single floor applications. Actual maximum spans are established by lo-

cal building codes (see reference source given in footnote 2 page 8 for complete description and product use information).

The Span Rating number is related to species and thickness of the panel face and back veneers and panel thickness. It is established by either one of the following procedures:

- (1) By specification as detailed in Table 6.
- (2) By performance testing to satisfy the strength, stiffness and durability criteria as detailed in 3.8.6. Such performance testing is to be performed by a qualified testing agency, as described in 6.1.1.

3.8.6. Performance testing qualification requirements

3.8.6.1. General—Acceptance of performance tested plywood under this Standard is based upon testing of panel strength, stiffness and durability. Panels selected for testing shall be of near minimum

Table 7. Concentrated Static and Impact Test Performance Criteria for Panels Tested According to 4.5.5. — Sheathing.

End Use — Span Rating	Test Exposure Conditions(e)	Performance Requirements		
		Minimum Ultimate Load (lb)		Maximum Deflection (in.) Under 200-lb Load(b)
		Static	Following Impact(d)	
Roof — 16	Dry	400	300	7/16 (.438) (c)
	Wet	400	300	
Roof — 20	Dry	400	300	15/32 (.469) (c)
	Wet	400	300	
Roof — 24	Dry	400	300	1/2 (.500) (c)
	Wet	400	300	
Roof — 32	Dry	400	300	1/2 (.500) (c)
	Wet	400	300	
Roof — 40	Dry	400	300	1/2 (.500) (c)
	Wet	400	300	
Roof — 48	Dry	400	300	1/2 (.500) (c)
	Wet	400	300	
Subfloor — 16	Dry	400	400	3/16 (.188) 3/16 (.188)
	Wet/Redry	400	400	
Subfloor — 20	Dry	400	400	7/32 (.219) 7/32 (.219)
	Wet/Redry	400	400	
Subfloor — 24	Dry	400	400	1/4 (.250) 1/4 (.250)
	Wet/Redry	400	400	

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry. Wet conditioning is exposure to three days continuous wetting and tested wet.

(b) Criteria apply under static concentrated load according to 4.5.5. They do not apply following impact.

(c) Not applicable.

(d) Impact shall be 75 ft-lb for Span Ratings up to 24 o.c., 90 ft-lb for 32 o.c., 120 ft-lb for 40 o.c., and 150 ft-lb for 48 o.c.

grade and near minimum thickness. Thickness sampling shall be such that the average panel thickness does not vary more than +0.010 inches from the minimum average panel in the lot. All provisions of veneer grade and panel workmanship are applicable.

3.8.6.2. Performance testing—Panels qualified by performance testing shall satisfy the criteria called for in this Section when tested in accordance with 3.8.6.3 and 3.8.6.4.

3.8.6.3. Structural performance

Concentrated loads

A minimum of ten tests (specimens taken from at least five panels) shall be conducted for both concentrated static and impact loads according to 4.5.5. The tests shall be conducted for each exposure condition specified in Table 7 or Table 9 (Wet, Dry, and/or Wet/Redry).

Deflection—At least 90% of tests shall deflect no more than the specified maximum.

Table 8. Uniform Load Performance Criteria for Panels Tested According to 4.5.6. — Sheathing.

End Use — Span Rating	Test Exposure Conditions ^(a)	Performance Requirements	
		Average Deflection (in.) Under Load (psf)	Minimum Ultimate Uniform Load (psf)
Roof — 16	Dry	0.067 at 35 psf	150
Roof — 20	Dry	0.080 at 35 psf	150
Roof — 24	Dry	0.100 at 35 psf	150
Roof — 32	Dry	0.133 at 35 psf	150
Roof — 40	Dry	0.167 at 35 psf	150
Roof — 48	Dry	0.200 at 35 psf	150
Subfloor — 16	Dry	0.044 at 100 psf	330
	Wet/Redry	0.044 at 100 psf	330
Subfloor — 20	Dry	0.053 at 100 psf	330
	Wet/Redry	0.053 at 100 psf	330
Subfloor — 24	Dry	0.067 at 100 psf	330
	Wet/Redry	0.067 at 100 psf	330

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

Table 9. Concentrated Static and Impact Test Performance Criteria for Panels Tested According to 4.5.5. — Single Floor.

Span Rating	Test Exposure Conditions ^(a)	Performance Requirements		
		Minimum Ultimate Load (lb)		Maximum Deflection (in.) Under 200-lb Load ^(b)
		Static	Following 75 ft-lb Impact	
16	Dry	550	400	5/64 (.078)
	Wet/Redry	550	400	5/64 (.078)
20	Dry	550	400	6/64 (.094)
	Wet/Redry	550	400	6/64 (.094)
24	Dry	550	400	7/64 (.108)
	Wet/Redry	550	400	7/64 (.108)

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

(b) Criteria applies under static concentrated load and following a 75 ft-lb impact according to 4.5.5.

Retest. If no more than two tests in a lot of ten fail to meet the deflection requirements, another lot of ten may be tested for that requirement. If no more than one test fails in this second round of testing, the requirements shall be considered as being satisfied.

Ultimate load—For each lot, 100% of tests shall support the specified minimum ultimate load.

Retest. If no more than one test in a lot of ten fails to meet the minimum ultimate load requirement, another lot of ten may be tested for that requirement. If all pass the retest, the requirements shall be considered as satisfied.

Uniform loads

A minimum of ten tests (specimens taken from at least five panels) shall be conducted for uniform load capacity according to 4.5.6. The tests shall be conducted for each exposure condition specified in Table 8 or Table 10.

Deflection—The average deflection shall not be greater than that specified.

Retest. If the average deflection is greater than specified, but does not exceed the requirement by 20%, another lot of ten may be tested for that requirement. If the average of the first and second lot taken together does not exceed that specified, the requirement shall be considered as being satisfied.

Ultimate load—For each lot, 100% of tests shall support the specified minimum ultimate load.

Retest. If no more than one test in a lot of ten fails to meet the ultimate load requirement, another lot of ten may be tested for that requirement. If all speci-

mens pass this retest, the requirements shall be considered as satisfied.

3.8.6.4. Bond durability—Panels shall be classed as "Exposure 1" or "Exterior."

Exposure 1

Panels rated as "Exposure 1" shall be so identified and shall satisfy the bond requirements for Interior panels bonded with exterior glue, as specified in 3.7.3.

Exterior

Panels rated as "Exterior" shall be so identified and shall satisfy the bond requirements specified in 3.7.4.

3.8.6.5. Product evaluation

Mill specification

Upon conformance with the appropriate requirements of 3.8.6.3 and 3.8.6.4, a manufacturing specification will be written based on product evaluation under Subsection 3.8.6.5. This specification is to be used for quality assurance purposes by the manufacturer and the qualified testing agency, per 6.1.1. Product evaluation will be accomplished on the same lot supplied by the manufacturer for qualification testing. Control values established during product evaluation will be the basis for quality evaluation of future production. The mill specification shall contain the following information:

Panel construction

Panels shall be defined as to veneer species and construction.

Table 10. Uniform Load Performance Criteria for Panels Tested According to 4.5.6. — Single Floor.

Span Rating	Test Exposure Conditions(a)	Performance Requirements	
		Average Deflection (in.) Under Load (psf)	Minimum Ultimate Uniform Load (psf)
16	Dry or Wet/Redry	0.044 at 100 psf	330
20	Dry or Wet/Redry	0.053 at 100 psf	330
24	Dry or Wet/Redry	0.067 at 100 psf	330

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

Thickness

The control value shall be the minimum average panel thickness as sampled under 3.8.6.1.

Mechanical properties

Bending stiffness—Twenty tests (specimens taken from at least ten panels) shall be evaluated for bending stiffness both along and across the major panel axis according to the procedures of 4.5.7. The control value for each panel direction will be the sample mean and the minimum will be the lower value of a 90% confidence interval established on the mean.

Bending strength—Ten tests (specimens taken from at least ten different panels) shall be tested for maximum bending moment both along and across the major panel axis according to the procedures of 4.5.7. The control value for each panel direction will be the minimum observed value, or the sample mean less 1.8 times the sample standard deviation, whichever is the higher value.

3.8.6.6. Reexamination

Quarterly reexamination

A product qualified by performance testing shall be subjected to quarterly reexamination by the manufacturer's qualified testing agency (6.1.1). Panels shall be tested according to the procedures of 3.8.6.5, Mechanical Properties.

Resampling—Failure to meet established control values shall result in an immediate intensive resampling of current production which will be tested for the failing property. This resampling shall consist of 20 panels.

Requalification—When results of the resampling fail to meet the applicable test requirements, a requalification for structural properties under 3.8.6.3 shall be required.

3.9. Scarf and finger jointed panels—Neither panels with N faces, nor the faces of such panels, unless longer than 10 feet, shall be scarf or finger jointed unless otherwise agreed to by buyer and seller. Panels of other grades may be scarf or finger jointed unless otherwise agreed to by buyer and seller, and panels longer than 12 feet are necessarily scarf or finger jointed. Plain scarfed joints and the scarfed portion of finger joints shall not have a slope greater than 1 to 8. All plies with grain perpendicular to the finger joint shall be included in the scarfed portions of the joint, except that such plies may include up

to 1/32 inch of vertical shoulder in the scarf (see Figure 5). Joints shall be glued with a waterproof adhesive and shall meet the test requirements set forth in 3.9.1, 3.9.2, 3.9.3, and 3.9.4 as applicable. In addition, the adhesive shall not show creep or flow characteristics greater than unjointed wood when subject to load under any conditions of temperature and moisture.

3.9.1. Strength requirements (Interior and Exterior scarf and finger jointed panels)—If the average ultimate stress of the three test specimens of any one panel is less than 4,000 psi for panels of Group 1 species, or less than 2,800 psi for panels of Group 2 or Group 3 species, or less than 2,400 psi for panels of Group 4 species, or less than 2,000 psi for panels of Group 5 species, when tested in accordance with 4.7.1, then that panel fails. The jointed panels represented by the sampling are acceptable if not more than one of the panels fails.

3.9.2. Scarf and finger joint durability for Interior panels bonded with interior glue—Scarfed panels shall be tested in accordance with 4.7.2. Finger jointed panels shall be tested in accordance with 4.7.4. Test specimens showing continuous delamination in excess of 1/16 inch deep and 1/2 inch long at the joint glueline shall be considered as failing. More than one failing specimen in a panel shall constitute failure of that panel. The jointed panels represented by the sampling are acceptable if not more than one of the panels fails.

3.9.3. Scarf joint durability for Exterior type plywood and Interior type bonded with exterior glue (Exposure 1) or intermediate glue—Panels shall be tested in accordance with 4.7.3. The material represented by the sampling shall be evaluated in accordance with 3.7.2, 3.7.3, and 3.7.4, as applicable.

3.9.4. Finger joint durability for Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or intermediate glue—Panels shall be tested in accordance with 4.7.5. The joints shall meet all of the following minimum conditions:

1. The average wood failure rating of all specimens from each panel when tested in accordance with 4.7.5 shall not be less than 85 percent.
2. No single specimen from a panel (average of face and back gluelines) shall rate less than 60 percent wood failure.
3. No single face or back glueline in any specimen shall rate less than 30 percent wood failure.

3.10. Dimensional tolerances and squareness of panels.

3.10.1. Size tolerances—A tolerance of plus zero (0) inch, minus 1/16 inch shall be allowed on the specified length and width.

3.10.2. Thickness tolerances—Sanded panels shall have a tolerance of plus or minus 1/64 inch for specified thicknesses of 3/4 inch and less and plus or minus 3.0 percent of the specified thickness for panels thicker than 3/4 inch. Unsanded, touch sanded, and overlaid panels shall have a tolerance of plus or minus 1/32 inch for specified thicknesses of 13/16 inch and less and plus or minus 5 percent of the specified thickness for panels thicker than 13/16 inch.

Panel thickness shall be based on a moisture content of 9 percent oven dry weight.

Panel thickness shall be measured with a micrometer having 3/4 inch (minus 0, plus 0.050 inch) diameter anvils. Measurement shall be taken at an applied anvil pressure of not less than 5 psi or more than 10 psi. The location of measurement shall be representative of general panel thickness at approximate mid-width on one end of each panel.

If that measurement is below minimum or above maximum requirements, three additional measurements shall be taken, one at approximate mid-width on the opposite end and one at approximate mid-length on each side of the panel, and the average of four measurements shall be taken as the thickness of that panel.

3.10.3. Squareness and straightness—Panels 4 feet or greater in length and width shall be square within 1/64 inch per lineal foot. Panels less than 4 feet in length or width shall be square within 1/16 inch measured along the short dimension. All panels shall be manufactured so that a straight line drawn from one corner to the adjacent corner shall fall within 1/16 inch of panel edge.

3.11. Moisture content—Moisture content of panels at time of shipment shall not exceed 18 percent of the oven dry weight when tested in accordance with 4.6.

3.12. Loading or packing—The plywood shall be securely loaded or packaged to ensure delivery to destination in a clean and serviceable condition.

4. SPECIMEN PREPARATION AND TESTING

4.1. General—The tests set forth in this Section shall be used to determine the glue bond quality of plywood produced under this Standard.

4.2. Specimen preparation (See appendix A4 for sampling for reinspection)—One test piece shall be cut from each panel selected. For panels bonded with interior glue, the test piece shall be cut into five test specimens 2 inches wide by 5 inches along the grain. For panels bonded with intermediate glue, five test specimens shall be cut as described in 4.4.1. For panels bonded with exterior glue, 10 test specimens shall be cut as described in 4.5.1. Of the 10 specimens cut from each test piece for panels bonded with exterior glue, five shall be for the vacuum-pressure test and five shall be for the boil test. From each overlaid panel selected, 10 additional test specimens shall be cut (as described in 4.5.1) to test the bond between the overlay and the base panel. In addition, from each panel selected, excluding Interior type panels bonded with interior glue, a 5-1/2 inch by 8 inch specimen shall be cut and tested as described in 4.5.4.

4.3. Test for Interior type bonded with interior glue—The test specimens prepared as described in 4.2 shall be placed in a pressure vessel and completely submerged in 110°F water. A vacuum of 15 inches of mercury shall be drawn, maintained for 30 minutes and released. Specimens shall then be allowed to soak in the same water at atmospheric pressure for 4-1/2 hours with no additional heating. They shall be removed and dried for 15 hours at 150°F in an oven with fan forced air circulation of 45 to 50 air changes per minute. Specimens shall then be examined for delamination and evaluated in accordance with requirements given in 3.7.1. Total continuous visible delamination of 1/4 inch or more in depth and 2 inches in length along the edges of a 2 inch by 5 inch test specimen shall be considered as failure. When required, this shall be determined by probing with a suitable feeler gage not greater than 0.013 inch in thickness. When delamination occurs as a result of a localized defect permitted in the grade, other than white pocket, that specimen shall be discarded.

4.4. Tests for Interior type plywood bonded with intermediate glue.

4.4.1. Preparation of test specimens—Test specimens shall be cut 3-1/4 inches long and 1 inch wide, and kerfed one-third of the length of the specimen from each end as illustrated in Figure 1 to provide a 1 inch square test area in the center. Specimens shall be oriented so that the grain direction of the ply under test runs at a 90° angle to the length of the specimen. Kerfing shall extend two-thirds of the way through the ply under test, and shall not penetrate the next glue line.

If the number of plies exceeds three, the cuts shall be made so as to test any two of the joints. The additional plies need not be stripped except as demanded by the limitations of the width of the retaining jaws on the testing device. When desired, special jaws may be constructed to accommodate the thicker plywood. If the number of plies exceeds three, the choice of joints to be tested shall be left to the discretion of the qualified inspection and testing agency, but at least one-half of the tests shall include the innermost joints.

4.4.2. Vacuum-soak test—The test specimens shall be placed in a pressure vessel and submerged in water at 120°F. A vacuum of 15 inches of mercury shall be drawn and maintained for 30 minutes. Following the release of the vacuum, specimens shall continue soaking for 15 hours at atmospheric pressure. The temperature of the water shall not drop below 75°F at any time during the 15 hour soaking

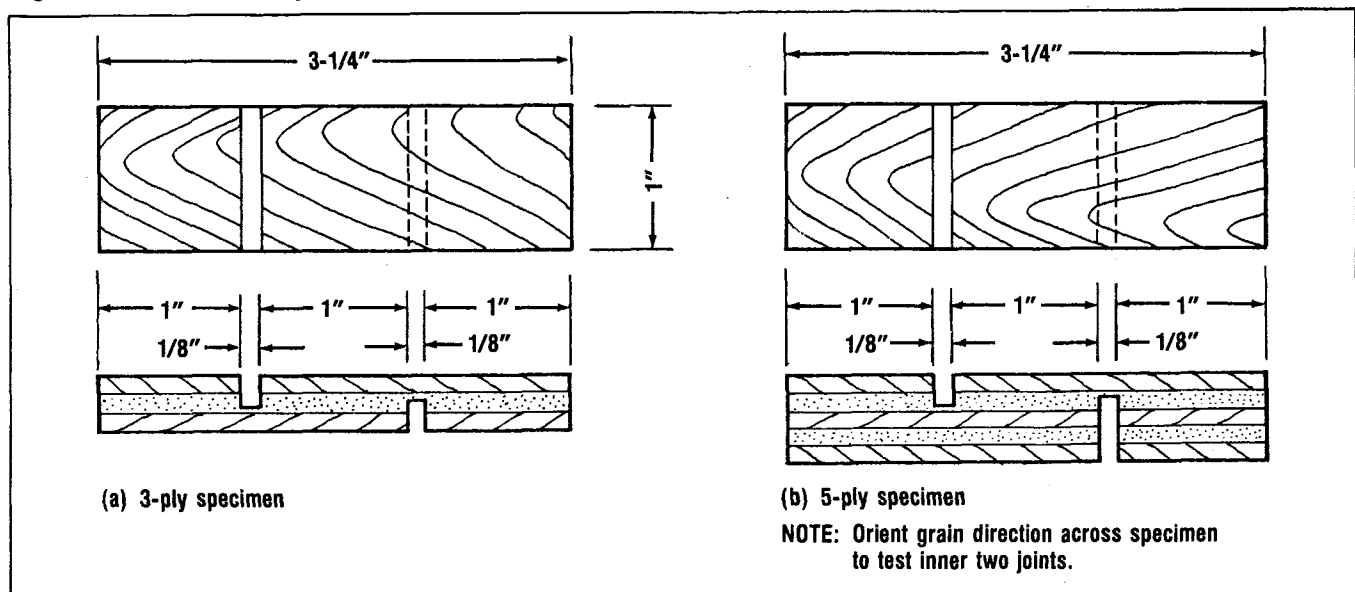
period. Specimens shall then be removed from the vessel and tested while wet by tension loading to failure in a shear testing machine operated at a maximum head travel of 16 inches per minute. Jaws of the machine shall securely grip the specimen so there is no slippage. The percentage of wood failure of the specimens shall be determined with specimens in a dry condition and shall be evaluated as described in 3.7.2.

4.5. Tests for Exterior type and Interior type bonded with exterior glue (Exposure 1).

4.5.1. Preparation of test specimens—Test specimens, taken as described in 4.2 shall be cut 3-1/4 inches long and 1 inch wide, and kerfed one-third of the length of the specimen from each end, as illustrated in Figure 1 to provide a 1 inch square test area in the center. Specimens shall be oriented so that the grain direction of the ply under test runs at a 90° angle to the length of the specimen. Kerfing shall extend two-thirds of the way through the ply under test, and shall not penetrate the next glue line. For overlaid plywood, the additional 10 specimens for testing of bond between veneers shall be cut as described above for Exterior specimens, except that, they shall be cut 1 inch wide and long enough for handling (3 inches is a convenient length) and kerfed just through the overlay 1 inch from the end, on each overlay face.

If the number of plies exceeds three, the cuts shall be made so as to test any two of the joints, but the additional plies need not be stripped except as

Figure 1. Shear Test Specimens



demanding by the limitations of the width of the retaining jaws on the testing device. When desired, special jaws may be constructed to accommodate the thicker plywood. If the number of plies exceeds three, the choice of joints to be tested shall be left to the discretion of the qualified inspection and testing agency, but at least one-half of the tests shall include the innermost joints.

4.5.2. Vacuum-pressure test—The test specimen shall be placed in a pressure vessel and submerged in cold tap water. A vacuum of 25 inches of mercury shall be drawn and maintained for 30 minutes, followed immediately with application of 65-70 psi of pressure for 30 minutes duration. Specimens shall then be removed from the vessel and tested while wet by tension loading to failure in a shear testing machine operated at a maximum head travel of 16 inches per minute. The jaws of the machine shall securely grip the specimens so there is no slippage. The percentage of wood failure of the specimens shall be determined in a dry condition and evaluated as described in 3.7.3 and 3.7.4.

The bond between veneers in overlaid plywood shall be tested in an identical manner and evaluated as described in 3.7.4. Specimens for testing the bond between the overlay and the base panel shall be subjected to the same test cycle described above. The bond between the overlay and the base panel shall be tested by inserting a sharp, thin blade of adequate stiffness into the corner of the 1 inch test area at the overlay-veneer interface, taking care not to cut into the overlay, and attempting to peel the overlay off. It may be necessary to reinsert the blade several times in order to remove the overlay from the 1 square inch area. The percentage of wood and/or fiber failure shall then be estimated with specimens in a dry condition and evaluated as described in 3.7.4. The value for each specimen shall be the average of the test areas on each face.

4.5.3. Boiling test—Test specimens shall be boiled in water for 4 hours and then dried for 20 hours at a temperature of $145^{\circ} \pm 5^{\circ}\text{F}$ with sufficient air circulation to lower moisture content of the specimens to a maximum of 8 percent, based on oven-dry weight. The specimens shall be boiled again for a period of 4 hours, cooled in water, and tested while wet by tension loading for failure in a shear testing machine operated at a maximum head travel of 16 inches per minute. Jaws of the machine shall securely grip the specimens so there is no slippage. The percentage of wood failure of the specimens shall be determined with specimens in a dry condition and evaluated as described in 3.7.3 and 3.7.4.

The bond between veneers in overlaid plywood shall be tested in an identical manner and evaluated as described in 3.7.4. Specimens to test the bond between the overlay and the base panels shall be subjected to the same test cycle described above. The bond between the overlay and the base panel shall be tested by inserting a sharp, thin blade of adequate stiffness into the corner of the 1-inch test area at the overlay-veneer interface, taking care not to cut into the overlay, and attempting to peel the overlay off. If may be necessary to reinsert the blade several times in order to remove the overlay from the 1 square inch area. The percentage of wood and/or fiber failure shall then be estimated with specimens in a dry condition and evaluated as described in 3.7.4. The value for each specimen shall be the average of the test areas on each face.

4.5.4. Heat durability test—A specimen cut as described in 4.2 shall be placed on a stand as illustrated in Figure 2. A specimen shall then be subjected to a $1,472^{\circ}$ to $1,652^{\circ}\text{F}$ flame from a Bunsen-type burner for a period of 10 minutes, or until a brown charred area appears on the back side, whichever occurs first. The burner shall be equipped with a wing top to envelop the entire width of the specimen in flame. The top of the burner shall be 1 inch from the specimen face and the flame 1-1/2 inches high. The flame shall impinge on the face of the specimen 2 inches from the bottom end. After the test, the sample shall be removed from the stand and the gluelines examined for delamination by separating the charred plies with a sharp, chisel-like instrument. Specimens shall be evaluated in accordance with the requirements of 3.7.4.1.

4.5.5. Tests for performance under concentrated static and impact loads

4.5.5.1. General

The general provisions of the most recent edition of ASTM E-661⁶ are to be followed.

4.5.5.2. Specimen preparation

Test specimens are specified in ASTM E-661, with the number required given in 3.8.6.3. Specimens may also be moisture cycled as required.

⁶Available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

4.5.5.3. Test procedure

Concentrated static

Procedures of ASTM E-661 are followed, except the test frame may be of steel rather than lumber using fasteners which simulate nails. The loading rate is to be 100 pounds per thirty seconds to yield failure within 5 minutes if a hand-pumped hydraulic loading system is used.

Concentrated impact

Procedures of ASTM E-661 Method A are followed, except:

- (1) The test frame may be of steel rather than lumber, using fasteners which simulate nails.
- (2) For Span Ratings greater than 24 o.c., the shot bag shall weigh 60 pounds.

The width of individual pieces in assembling a test shall be 24 inches or greater for Span Ratings up to 24 o.c., and 48 inches for greater Span Ratings.

4.5.6. Test for performance under uniform loads

4.5.6.1. General

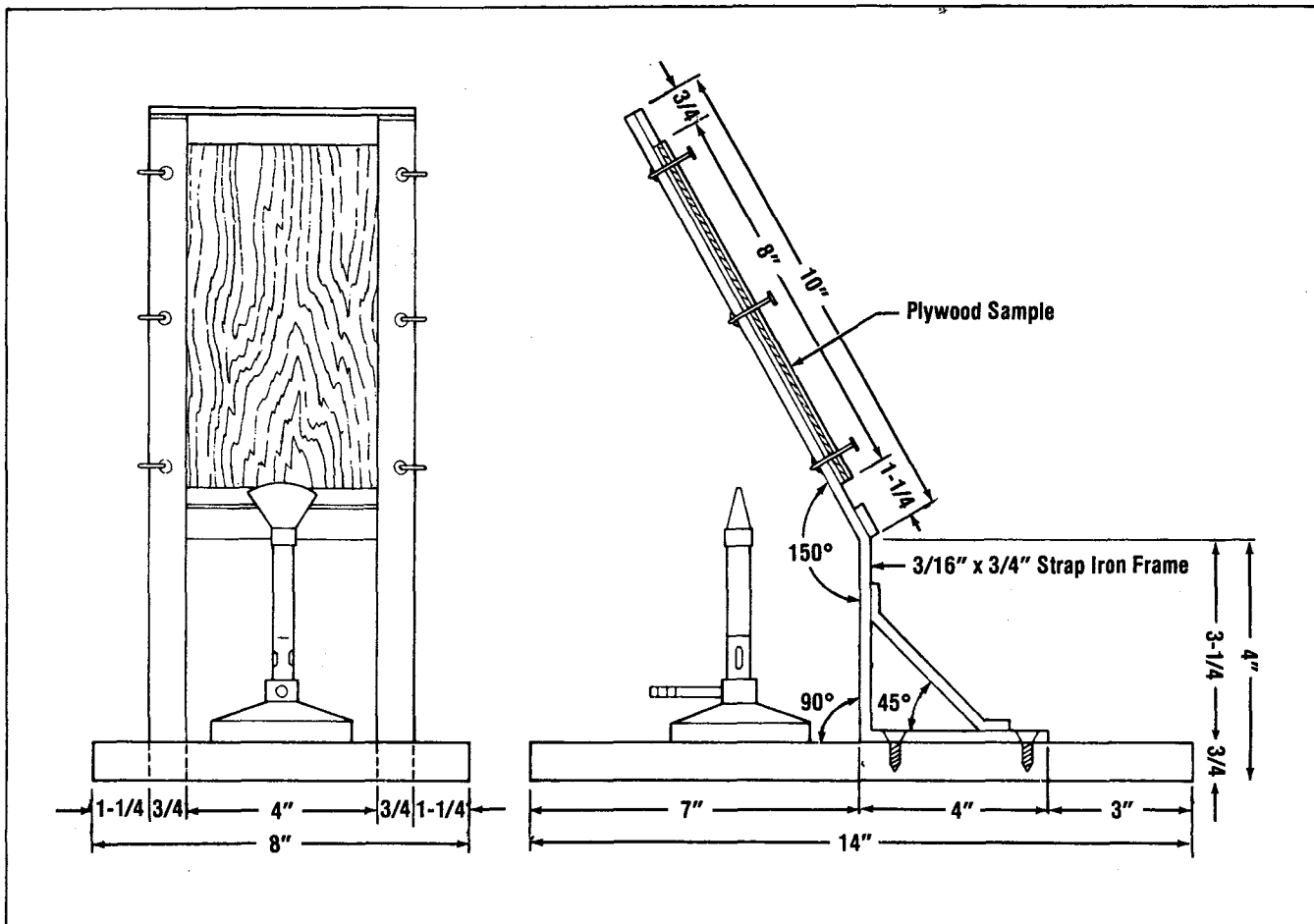
This method covers a procedure for determining the performance of structural-use panels under uniform loads such as snow, wind and occupancy loads. The uniform load is applied by atmospheric pressure as a vacuum is drawn under the test specimen which is mounted on fully supported framing members in a vacuum chamber.

4.5.6.2. Equipment

Vacuum chamber

The vacuum chamber (see Figure 3) consists of a sealed box with the panel to be tested forming the top. A 6-mil polyethylene sheet or equivalent, the per-

Figure 2. Apparatus for Heat Durability Test



imeter of which is attached securely with tape, seals the top surface of the vacuum chamber. The chamber must be strong and rigid to resist the applied load without failure or excessive deformation. A vacuum pump is used to reduce the air pressure under the specimen. The load is measured with absolute pressure gages for electronic data readout, but manometers or vacuum gages may also be used.

Joist supports

The framing members are supported so as to resist deflection or rotation under applied load.

Deflection gages

The deflection gages are mounted to rigid tripods whose legs rest above the joists. Deflection is measured to the nearest 0.001 inch.

4.5.6.3. Specimen preparation

Samples are to be selected that are representative of the product being tested.

Length

The specimen length perpendicular to the framing member is to be equal to twice the center-to-center spacing.

Width

The specimen width is to be at least 23-1/2 inches.

Thickness

The specimen thickness is to be measured after conditioning and recorded.

Conditioning

Prior to testing, the specimen may be subjected to conditioning as specified in ASTM E-661.

4.5.6.4. Test procedure

After conditioning, the specimen to be tested is mounted on the framing members in the vacuum chamber in accordance with the anticipated joist spacing and the recommended nail size and spacing. The top of the vacuum chamber is then sealed with the polyethylene sheet, and the tripod holding the deflection gages set in its proper position with the gages positioned to read deflection at the point of maximum deflection⁷ of the two outer spans (Figure 4).

The panel shall be loaded at a uniform rate of 50 pounds per square foot per minute recording deflections at 25 pounds per square foot increments until maximum load is achieved or until the desired proof load is achieved, as required. Deflection data is required only in sufficient numbers to develop the straight line portion of the load-deflection curve. In no case should the number of data points be less than six. Deflection at a given load is determined by translating the slope to pass through the origin, thereby correcting for any settling of the system.

4.5.7. Test for panel bending

4.5.7.1. General

This test procedure provides the basic data regarding full panel bending strength and stiffness. The general provisions of ASTM D-3043⁸ Method C are followed.

4.5.7.2. Specimen preparation

Specimens are to be prepared according to ASTM D-3043 Method C, except specimen size shall be 4x4-foot half panels.

4.5.7.3. Test procedure

The procedures of ASTM D-3043 Method C are followed except specimens are tested for stiffness both along and across the major panel axis, and maximum bending moment is taken as required.

⁷The point of maximum deflection for a uniformly loaded two-span system occurs at 0.4215 (S) measured from the centerline of the outer joist, where S equals the center-to-center joist spacing.

⁸See footnote 6 on page 27.

Figure 3. Vacuum Chamber Test Equipment

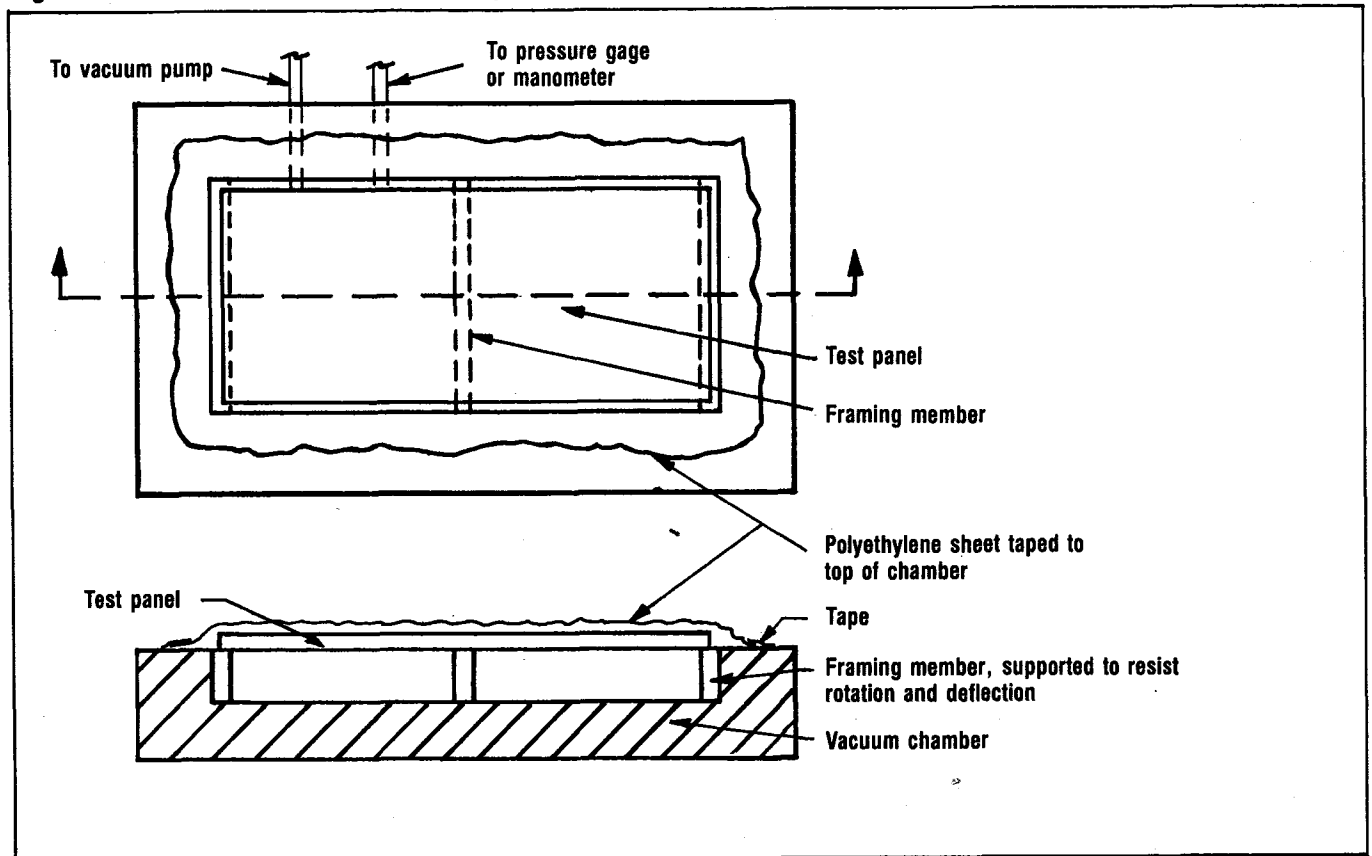
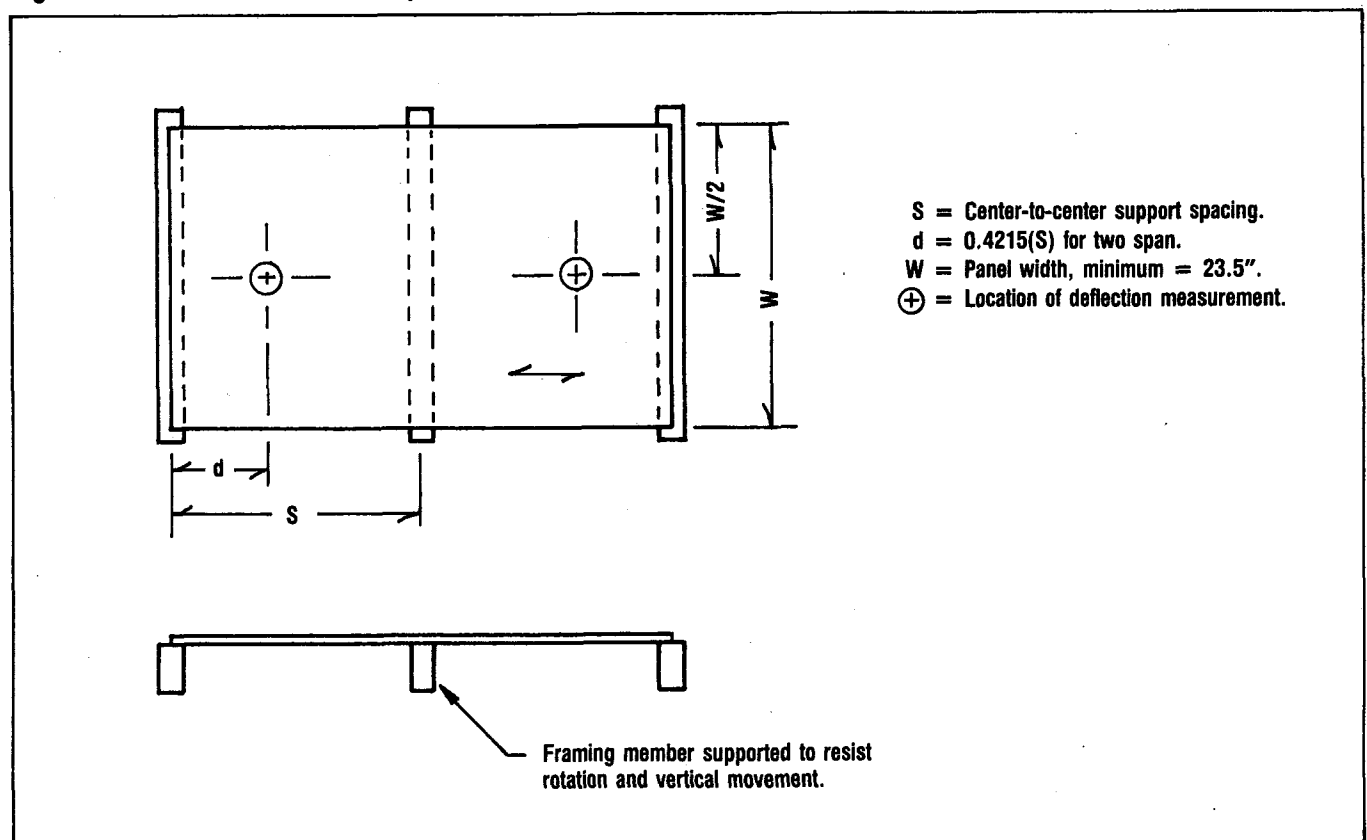


Figure 4. Uniform-Load Test Specimens



4.6. Test for determination of moisture content (oven-drying method)—The moisture content of the plywood shall be determined as follows: A small test specimen shall be cut from each sample panel; the test specimen shall measure not less than 9 square inches in area and shall weigh not less than 20 grams (approximately 3/4 ounce). All loose splinters shall be removed from the specimen. The specimen shall be immediately weighed on a scale that is accurate to ± 0.5 percent, and the weight shall be recorded as the "original" weight. The specimen shall then be dried in an oven at 212° to 221°F until constant weight is attained. After drying, the specimen shall be reweighed immediately, and this weight shall be

recorded as the "oven-dry" weight. The moisture content shall be calculated as follows:

$$\frac{\text{Original weight} - \text{Oven-dry weight}}{\text{Oven-dry weight}} \times 100 = \text{Moisture content (percent)}$$

4.7. Scarf and finger-joint tests.

4.7.1. Scarf and finger-joint strength—Three test specimens shall be cut at random along each joint from each panel selected. Type, grade and species of the panels shall be recorded. The specimens shall be cut so as to include the joint and shall be prepared as illustrated in Figure 5.

Figure 5. Tension Specimen for Scarfed Jointed Panels

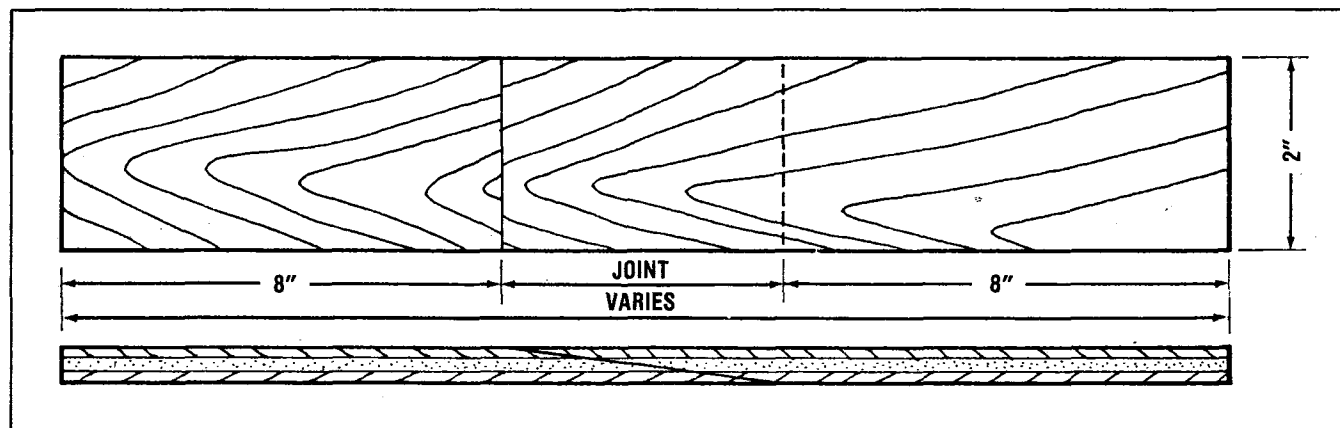
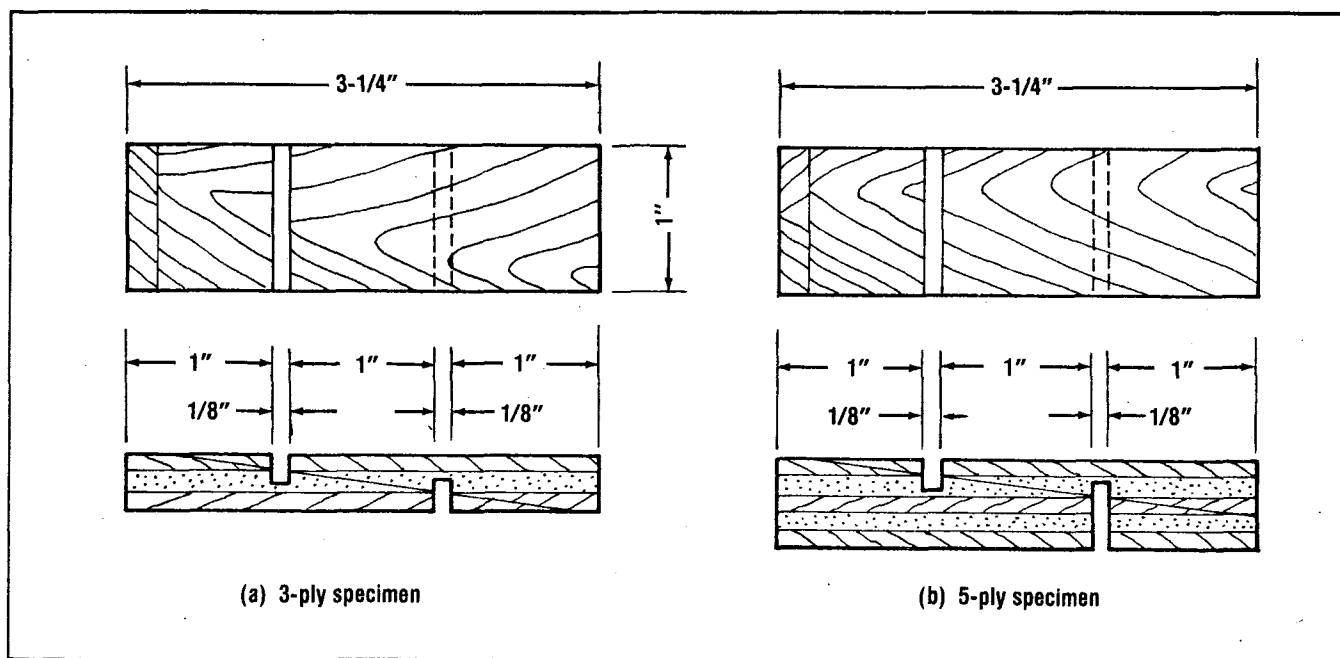


Figure 6. Specimen Preparation



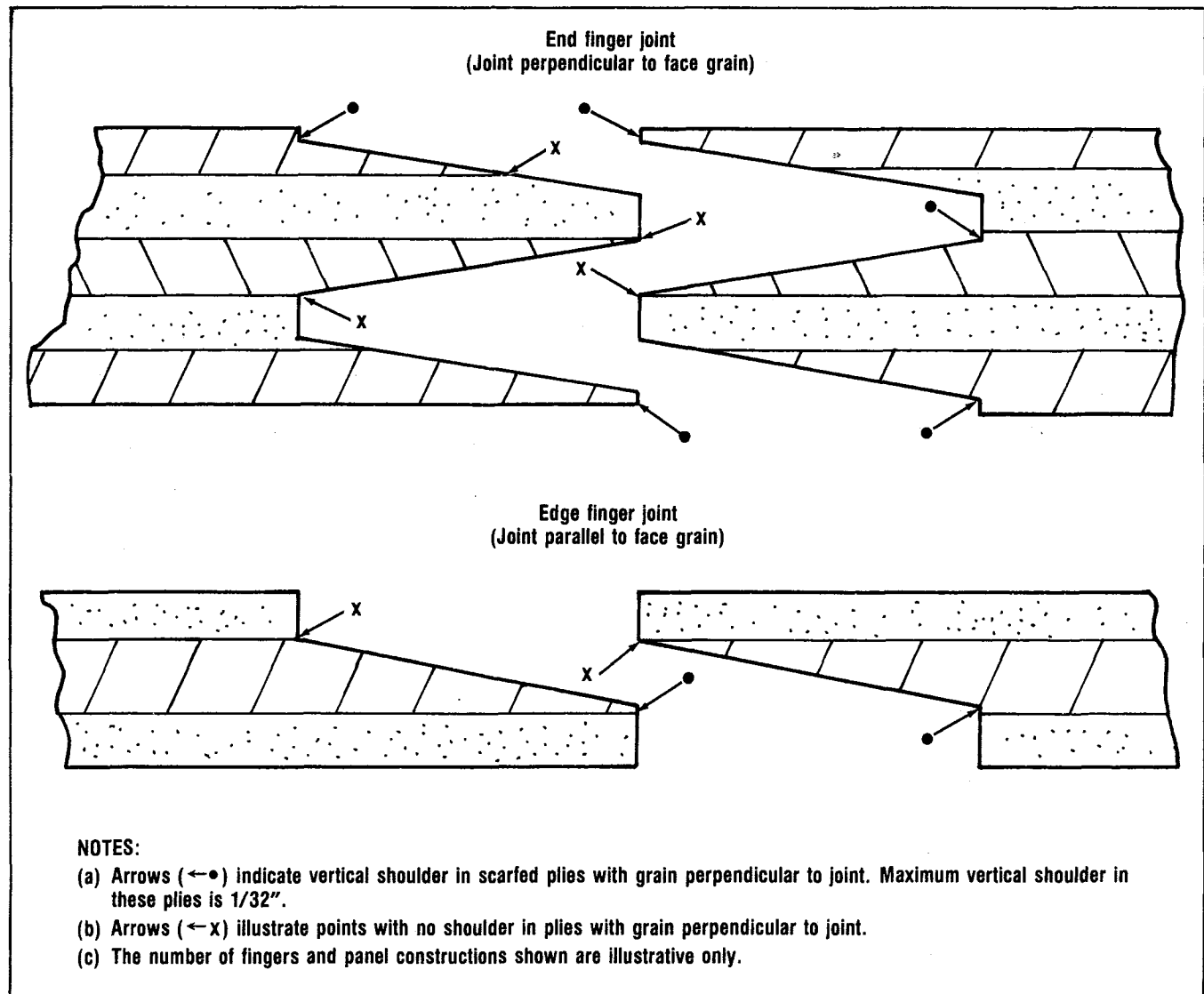
Insofar as possible, the joint test area shall contain no localized natural defects permitted within the grade. At the joint, the maximum thickness and width of plies parallel with the load shall be recorded. Each specimen shall then be placed in the tension grips of a testing machine and loaded continuously at a rate of cross-head travel of from 0.030 to 0.040 inches per minute until failure, and the ultimate load shall be recorded. The ultimate stress in lbs. per sq. in. shall be computed using the ultimate load and area of those plies whose grain is parallel with direction of load. Moisture content of the specimens at the time of testing shall not exceed 16 percent.

4.7.2. Scarf joint durability of Interior type panels bonded with interior glue—Ten test specimens shall be cut at random along each scarf joint from each

panel selected and shall be prepared following the general procedure in 4.2, but shall be cut so that the scarf joint occurring on one surface of the panel runs across the middle of five specimens and the joint occurring on the opposite surface runs across the middle of the other five specimens. The specimens shall be subjected to the same test procedure as outlined in 4.3.

4.7.3. Scarf joint durability of Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or intermediate glue—Ten test specimens shall be cut at random along each joint from each panel selected according to 4.2. The specimens shall be prepared following the general procedure described in 4.4.1 and 4.5.1 but, in addition, shall be cut so that the joint runs through the test specimens as shown in Figure 6.

Figure 7. Finger Joints — Location of Scarfed Portion of Joints



For Exterior type panels and Interior type panels bonded with exterior glue five specimens shall be subjected to the vacuum pressure test described in 4.5.2, and five to the boiling test of 4.5.3. The panels shall be evaluated as described in 3.7.3 and 3.7.4.

For Interior type panels bonded with intermediate glue, the ten specimens shall be subjected to the vacuum soak test outlined in 4.4.2. The panels shall be evaluated as described in 3.7.2.

4.7.4. Finger-joint durability of Interior type panels bonded with interior glue—Five specimens shall be cut at random along the finger joint from each panel selected and shall be prepared following the general procedure in 4.2, so that the middle of the joint coincides with the middle of the five specimens. The specimens shall be subjected to the same test procedure as outlined in 4.3.

4.7.5. Finger-joint durability of Exterior type panels and Interior type panels bonded with exterior glue (Exposure 1) or intermediate type glue—Ten specimens shall be cut at random along the finger

joint from each panel selected according to 4.2. These specimens shall be cut so as to include the joint and shall be prepared as illustrated in Figure 8.

For Exterior type panels and Interior type panels bonded with exterior glue, five of the specimens shall be subjected to the vacuum-pressure test of 4.5.2 and five to the boiling test of 4.5.3.

For Interior type panels bonded with intermediate glue, the ten specimens shall be subjected to the vacuum-soak test of 4.4.2.

Upon completion of the vacuum-pressure and boil tests, or vacuum-soak tests, as applicable, a wedge or chisel (see Figure 9) shall be inserted in locations shown in Figure 8 in such a manner as to pry apart the scarfed portions of the joint without directly contacting the glued area. Test specimens shall be dried and percent wood failure in the test area estimated and applied separately for both the boil and vacuum-pressure treatments. The panels shall be evaluated as described in 3.9.4.

Figure 8. Cleavage Test, Typical Test Specimen

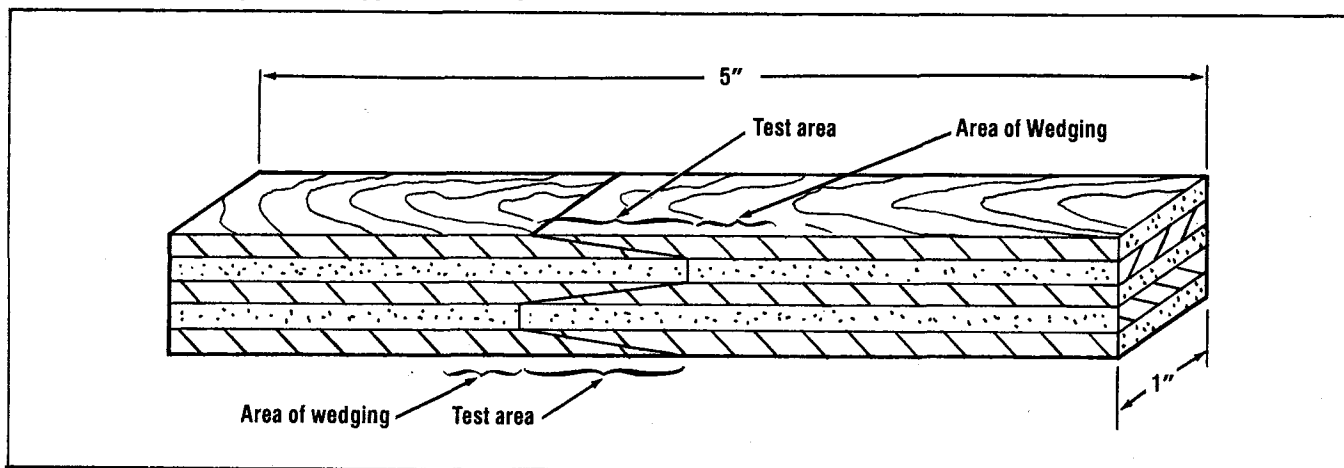
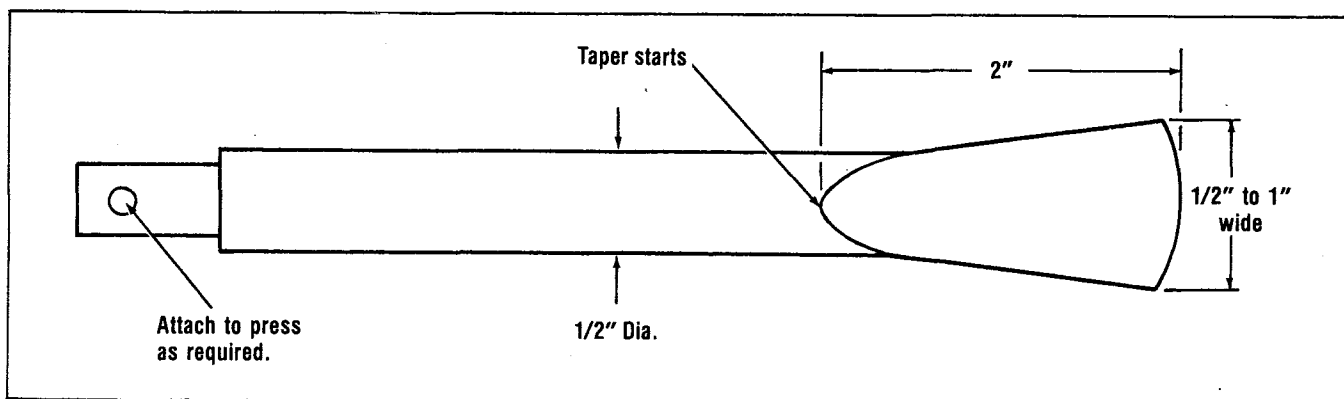


Figure 9. Wedge or Chisel Used for Cleavage Test



5. DEFINITIONS

5.1. For the purpose of this Standard, the following definitions shall apply:

Back —

The back of a plywood panel; the side of a panel that is of lower veneer quality on any panel whose outer plies (front and back) are of different veneer grades.

The back ply of a plywood panel; the outer veneer on the back side of a panel.

Borer holes — Voids made by wood-boring insects, such as grubs or worms.

Broken grain — A (leafing, shelling, grain separation) separation on veneer surface between annual rings.

Butt joint — A straight joint in which the interface is perpendicular to the panel face. An end butt joint is perpendicular to the grain.

Centers — Inner layers whose grain direction runs parallel to that of the outer plies. May be of parallel laminated plies.

Center gap — (See crossband gap)

Check — A lengthwise separation of wood fibers, usually extending across the rings of annual growth, caused chiefly by strains produced in seasoning.

Class I, II — Term used to identify different species group combinations of B-B concrete form panels. (See 3.6.4.)

Construction (panel construction) — Term referring to detailed manner in which veneers are assembled and/or thickness of veneer used, e.g., "4-ply construction"/"3-layer construction", "1/10 inch face and back", etc.

Core — Sometimes referred to as "crossband."

Crossband — Inner layers whose grain direction runs perpendicular to that of the outer plies. May be of parallel laminated plies. Sometimes referred to as core.

Crossband gap and center gap — An open joint extending through or partially through a panel, which results when crossband or center veneers are not tightly butted.

Defects, open — Irregularities such as splits, open joints, knotholes, or loose knots, that interrupt the smooth continuity of the veneer.

Delamination — A visible separation between plies that would normally receive glue at their interface and be firmly contacted in the pressing operation. Wood characteristics, such as checking, leafing, splitting, and broken grain, are not to be construed as delamination. See corresponding definition for those terms.

(a) For purpose of reinspection, areas coinciding with open knotholes, pitch pockets, splits, and gaps and other voids or characteristics permitted in the panel grade are not considered in evaluating ply separation of Interior type panels bonded with interior or intermediate glue.

(b) In evaluating Interior panels bonded with exterior glue (Exposure 1), delamination in any glue line shall not exceed three square inches except where directly attributable to defects permitted in the grade as follows:

Delamination associated with —

— Knots and knotholes — shall not exceed the size of the defect plus a surrounding band not wider than 3/4 inch.

— All other forms of permissible defects — shall not exceed the size of the defect.

(c) In evaluating Exterior type panels for ply separation, the area coinciding with the grade characteristics noted in paragraph (a) are considered, and a panel is considered delaminated if visible ply separation at a single glue line in such area exceeds three square inches.

Edge splits — Wedge-shaped openings in the inner plies caused by splitting of the veneer before pressing.

Face —

The face of the plywood panel; the side of a panel that is of higher veneer quality on any panel whose outer plies (front and back) are of different veneer grades; either side of a panel where the grading rules draw no distinction between faces.

The face ply of a panel; the outer veneer on the face of a panel.

Grade name — Term used to identify panels having special characteristics and/or requirements as described under Section 3.6, such as Marine, Decorative, and Underlayment.

Group — Term used to classify species covered by this Standard. Species covered by this Standard are classified as Groups 1, 2, 3, 4, and 5. See Table 1 for listing of species in individual groups and the reference in Section 2 for product use information.

Heartwood — Nonactive core of a log generally distinguishable from the outer portion (sapwood) by its darker color.

Inner plies — Plies other than face or back plies in a panel construction. Sub-face, sub-back, crossband and center are classed as inner plies.

Jointed inner plies — Crossband and center veneer that has had edges machine-squared to permit tightest possible layup.

Knot — Natural characteristic of wood that occurs where a branch base is embedded in the trunk of a tree. Generally the size of a knot is distinguishable by (1) a difference in color of limbwood and surrounding trunkwood; (2) abrupt change in growth ring width between knot and bordering trunkwood; and (3) diameter of circular or oval shape described by points where checks on the face of a knot that extend radially from its center to its side experience abrupt change in direction.

Knotholes — Voids produced by the dropping of knots from the wood in which they are originally embedded.

Lap — A condition where the veneers are so placed that one piece overlaps the other.

Layer — A layer is a single veneer ply or two or more plies laminated with parallel grain direction. Two or more plies laminated with grain direction parallel is a "parallel laminated layer".

Lot — Any number of panels considered as a single group for evaluating conformance to this Standard.

Nominal thickness — Full "designated" thickness. For example, 1/10 inch nominal veneer is 0.10 inch thick. Nominal 1/2 inch thick panel is 0.50 inch thick. Also, commercial size designation, subject to acceptable tolerances.

Patches — Inserts of sound wood or synthetic material in veneers or panels for replacing defects. "Boat" patches are oval-shaped with sides tapering in each direction to a point or to a small rounded end; "Router" patches have parallel sides and rounded ends. "Sled" patches are rectangular with feathered ends.

Pitch pocket — A well-defined opening between rings of annual growth, usually containing, or which has contained, pitch, either solid or liquid.

Pitch streak — A localized accumulation of resin in coniferous woods which permeates the cells forming resin soaks, patches, or streaks.

Plugs — Sound wood of various shapes, including among others, circular and dog-bone, for replacing defective portions of veneers. Also synthetic plugs used to fill openings and provide a smooth, level, durable surface. Plugs usually are held in veneer by friction until veneers are bonded into plywood.

Plugged inner plies — (Also referred to as solid inner plies.) — Refers to ϕ Plugged crossband and centers and additional limitations, as given in 3.8.1.

Ply — A single veneer lamina in a glued plywood panel. (See also layer.)

Plywood — Plywood is a flat panel built up of sheets of veneer called plies, united under pressure by a bonding agent to create a panel with an adhesive bond between plies as strong as or stronger than, the wood. Plywood is constructed of an odd number of layers with grain of adjacent layers perpendicular. Layers may consist of a single ply or two or more plies laminated with parallel grain direction. Outer layers and all odd numbered layers generally have the grain direction oriented parallel to the long dimension of the panel. The odd number of layers with alternating grain direction equalizes strains, reduces splitting, and minimizes dimensional change and warping of the panel.

Repair — Any patch, plug, or shim.

Rough grain — Grain characteristics which prevent sanding to a smooth surface.

Sapwood — The living wood of lighter color occurring in the outer portion of a log. Sometimes referred to as "sap."

Shim — A long, narrow repair of wood or suitable synthetic not more than 3/16 inch wide.

Shop-cutting panel — A shop-cutting panel is one which has been rejected as not conforming to a standard grade because of deficiencies, other than adhesive bond quality, which prevents it from meeting the requirements of this Standard. Blistered panels are not considered as coming within the category of "shop-cutting" panel. Localized delamination may occur as a result of a deficiency. However, shop-cutting panels may be suitable for cut-up use where cutting eliminates the deficiency in the portion of the panel salvaged. Such a panel must be identified with a separate mark as specified in 6.2.1.

Span Rating — A set of numbers used in marking sheathing and combination subfloor-underlayment (single floor) grades of plywood as described in 3.8.5. Formerly called Identification Index.

Split — Lengthwise separation of wood fibers completely through the veneer, caused chiefly by the manufacturing process or handling.

Streaks — See "Pitch streak."

Sub-face (Sub-back) — The ply adjacent to the exposed face (or back) of a parallel laminated outer layer.

Touch-sanding — A sizing operation consisting of a light surface sanding in a sander. Sander skips to any degree are admissible.

Veneer — Thin sheets of wood of which plywood is made. Also referred to as "plies" in the glued panel.

Wane — Thin to open areas in veneer sheets that result from outer log surface irregularities. Generally, only veneer peeled from the outer log surface will contain wane. Some wane areas may contain bark inclusions. For grading, wane is classed as an open defect.

Waterproof adhesive — For purposes of this Standard, glue capable of bonding plywood in a manner to satisfy the exterior performance requirements given herein.

White pocket — A form of decay (*Fomes pini*) that attacks most conifers but has never been known to develop in wood in service. In plywood manufacture, routine drying of veneer effectively removes any possibility of decay surviving. (Admissible amounts

of white pocket permitted by this Standard were established through a 2-year research project at the U.S. Forest Products Laboratory.)

Light white pocket — Advanced beyond incipient or stain stage to point where pockets are present and plainly visible, mostly small and filled with white cellulose; generally distributed with no heavy concentrations; pockets for the most part separate and distinct; few to no holes through the veneer.

Heavy white pocket — May contain a great number of pockets, in dense concentrations, running together and at times appearing continuous; holes may extend through the veneer but wood between pockets appears firm. At any cross section extending across the width of the affected area, sufficient wood fiber shall be present to develop not less than 40 percent of the strength of clear veneer. Brown cubicle and similar forms of decay which have caused the wood to crumble are prohibited.

Wood failure (percent) — The area of wood fiber remaining at the glue line following completion of the specified shear test. Determination is by means of visual examination and expressed as a percent of the test area.

6. GRADEMARKING AND CERTIFICATION

6.1. Certification of shipments—In order to assure that the purchaser is getting plywood of the grade and quality specified, the producer shall include with each shipment a "Certificate of Inspection" which states that the plywood conforms to this Standard. Each panel certified as being in conformance with this Standard shall bear the stamp of a qualified inspection and testing agency which (1) either inspects the manufacture (with adequate sampling, testing of glue line, and examination for quality of all veneers) or which (2) has tested a randomized sampling of the finished panels in the shipment being certified for conformance with this Standard. All plywood that is trademarked or otherwise designated as being in conformity with this Standard shall be accompanied by such Certificates of Inspection and applicable grade-trademarks of such inspection and testing agency as outlined above.

6.1.1. Qualified inspection and testing agency—A qualified inspection and testing agency is defined to be one that:

- (a) has the facilities and trained technical personnel to verify that the grading, measuring, species, construction, sanding, bonding, workmanship, and other characteristics of the products as determined by inspection, sampling and testing conform to all of the applicable requirements specified herein;
- (b) has developed procedures to be followed by agency personnel in performance of the inspection and testing;
- (c) has no financial interest in, or is not financially dependent upon, any single company manufacturing the product being inspected or tested; and
- (d) is not owned, operated, or controlled by any such company.

6.2. Panel marking—All panels represented as conforming to this Standard shall be identified with marks giving the following information:

- (a) **Species group number, Span Rating and Class**—Unless otherwise provided, panels which are produced with face and back veneers of the same species group shall be identified as being of that species group. Touch-sanded panels without Span Ratings that are manufactured with face and back plies of different species groups shall be identified by the larger numbered species group (i.e., Group 4 is larger numbered than Group 1). Sanded panels 3/8 inch or less in thickness, and Decorative panels of any thickness, that are manufactured with face and back plies of different species groups shall be identified by the face species group number. Sanded panels greater than 3/8 inch that are manufactured with face and back plies of different species groups shall be identified by the larger numbered species group, except that sanded panels with C or D grade backs may be identified by the face species group number if backs are no more than one species group larger in number than the face and are 1/8 inch or thicker before sanding. A class number as provided in 3.6.4 shall be used in lieu of a species group number to identify concrete form panels and a Span Rating shall be used for unsanded and touch-sanded grades as provided for in 3.8.5.

- (b) **Either "Interior", "Exposure 1" or "Exterior"**—Panels not fully satisfying exterior veneer requirements shall be identified as "Interior" or "Exposure 1". When panels are identified as "Interior" the additional notation "exterior glue" or "intermediate (IMG)" shall be used where applicable to supplement the designation of Interior grades bonded with exterior glue or intermediate glue. Any further reference to adhesive bond, including those which imply premium performance or special warranty by the manufacturer, as well as manufacturer's proprietary designations, shall be separated from the grademarks or trademarks of the testing agency by not less than 6 inches.

- (c) The grade name or the grade of face and back veneers or a mark of a qualified inspection and testing agency. If identified by such a mark, the product specification shall be available from the qualified inspection and testing agency whose mark appears on the panel.

- (d) The symbol PS 1-83 signifying conformance with this Standard.

- (e) The manufactured thickness of panels if other than standard nominal thickness, except for panels meeting the requirements of Table 6. For standard nominal thickness, see Appendix A1.2.

- (f) The designation "Butt-Jointed Center" for those panels manufactured with butt-joints in center plies in accordance with 3.8.

6.2.1. Voiding marks—Panels originally marked as conforming to this Standard but subsequently rejected as not conforming thereto shall have any reference to the Standard voided or obliterated by the manufacturer as follows:

Such panels shall be plainly marked by means of a 4 inch by 5 inch minimum size rectangular stamp carrying the legend, "Shop-cutting panel — all other marks void". (See definition of shop-cutting panel.)

No reference shall be made to this Standard in the certification or grade trademarking of panels not conforming to all of the applicable provisions of this Standard.

7. EFFECTIVE DATE

The effective date of this Standard is December 30, 1983. The authority to refer to the superseded standard, PS 1-74, *Construction and Industrial Plywood*, as a voluntary standard developed under the Department of Commerce procedures is terminated as of April 30, 1984. As of the effective date, reference to PS 1-83 may be made in contracts, codes, advertising, invoices, product labels, and the like, but no product may be advertised or represented in any manner which would imply or tend to imply approval or endorsement of that product by the National Bureau of Standards, the Department of Commerce, or by the Federal Government.

8. HISTORY OF PROJECT

On October 1, 1965, the American Plywood Association submitted to the National Bureau of Standards a draft of a proposed Commercial Standard for softwood plywood together with a request that it be processed as a revision and consolidation of Commercial Standards CS45-60, "Douglas Fir Plywood," CS122-60, "Western Softwood Plywood," and CS259-63, "Southern Pine Plywood." On December 16, 1965, procedures for the development of Voluntary Product Standards were published in final form and this Standard became the first Voluntary Product Standard to be processed under the new procedures. The proposal was reviewed by the National Bureau of Standards, the Forest Products Laboratory in Madison, Wisconsin, and by other Federal agencies with a prime interest in the product.

Acceptances were received from producers of 85 percent of the production of softwood plywood, from many distributors, specifiers, architects, home builders, contractors, component and container manufacturers, as well as from State and Federal governmental agencies. The acceptances were considered to represent a satisfactory consensus, and there were no outstanding substantive objections deemed valid by the Bureau. Accordingly, the successful establishment of Product Standard PS1-66, "Softwood Plywood, Construction and Industrial," was announced on October 18, 1966, to become effective for new production on November 1, 1966. Commercial Standards CS45-60, CS122-60 and CS259-63 were superseded by PS1-66 in December, 1966.

In April 1972, the APA requested that the National Bureau of Standards initiate a revision of PS1-66

under the "Procedures for the Development of Voluntary Product Standards." A proposed revision was submitted to the Standing Committee in September 1973; the response from the Standing Committee indicated that certain changes to the standard were necessary.

A proposal was approved by the Standing Committee in March 1974. The recommended revision was then circulated for acceptance in May 1974. The response to this circulation indicated consensus among producers, distributors, and users in accordance with the published procedures.

The revised Standard was designated Voluntary Product Standard PS1-74, "Construction and Industrial Plywood," and became effective on August 1, 1974.

Current edition

In February 1982, the APA requested the initiation of a revision of PS1-74 under the revised "Procedures for the Development of Voluntary Product Standard." A proposed revision was submitted to the Standing Committee in January 1983. After several minor changes, the proposed standard was approved by the Standing Committee in March 1983. The recommended version was circulated for acceptance in April 1983, and changes were circulated in October 1983. The response to the circulation indicated a consensus among producers, distributors, and users in accordance with the published procedures.

The Standard was designated Voluntary Product Standard PS1-83 "Construction and Industrial Plywood," and became effective on December 30, 1983.

9. STANDING COMMITTEE

A Standing Committee has been appointed to assist in keeping this Voluntary Product Standard up to date in accordance with the published procedures. The names of the members of the committee are available from the Office of Product Standards Policy, National Bureau of Standards, Washington, D.C. 20234, which serves as the secretariat of the committee.

APPENDIX

Based on industry practice the following information is offered plywood purchasers:

A1. Sizes and Thicknesses

A1.1. Standard sizes—Plywood is generally available in panel widths of 36, 48, and 60 inches, and in panel lengths ranging from 60 inches to 144 inches in 12 inch increments. Other sizes are also available on special order. Panels 48 inches wide by 96 inches long (4 feet by 8 feet), and 48 inches wide by 120 inches long (4 feet by 10 feet) are most commonly available.

A1.2. Standard thicknesses—The standard nominal thicknesses of sanded panels range from 1/4 inch to 1-1/4 inches and greater, in 1/8 inch increments. The standard nominal thicknesses of unsanded panels range from 5/16 inch to 1-1/4 inches and greater, in increments of 1/8 inch for thicknesses over 3/8 inch. The manufactured thickness of a panel of other than standard nominal thickness is marked on the panel. Tolerances are as provided in 3.10.2.

A2. Overlaid plywood—The overlay face of High Density Overlay is usually produced in a natural translucent color, but certain other colors may be available. Color stability under weathering conditions is not a part of this Standard.

The overlay face of Medium Density Overlay characteristically is opaque and is produced in a natural color as well as in certain other colors.

A3. Method of ordering —

(a) The regular method of specifying sanded grades of plywood is to designate the species group, number of pieces, width, length, number of plies, type, grade, and finished thickness. Width always refers to the distance across the grain of the face plies; length refers to the distance along the grain. Width should always be specified first. If, for example, the requirement is 100 pieces of Group 2 plywood 1/4 inch thick, 48 inches wide, and 96 inches long, for interior conditions, one side of which is to be nailed against a wall where it will not show, but the other side is to be exposed to view and painted, this material should be ordered as follows:

“Group 2 plywood: 100 pcs. 48 inch by 96 inch, 3-ply Interior type, A-D grade, sanded two sides to 1/4 inch thickness.”

- (b) **Surface finish**—For most uses, except for sheathing, sanded panels are desirable, but there are occasional uses where unsanded panels, of an A-D or other grade, are satisfactory. Such panels should be specified “unsanded”, with notation made of any special patching requirements and the unsanded thickness specified.
- (c) **Special types of service**—Special features may be desirable in plywood panels, such as extra thick faces for certain architectural treatments. In such cases, the special treatment or feature should be stated after the standard specification.

For example, if special features are desired in Group 3 Exterior type, A-A grade panels of 3/8 inch thickness, the order should read:

“Group 3 plywood: 100 pcs., 48 inch by 96 inch, 3-ply Exterior type, A-A grade, sanded two sides to 3/8 inch thickness (add further special requirements).”

- (d) **Overlaid plywood**—When ordering overlaid plywood, the basic description should be specified such as “High Density Overlay” (HDO), “Medium Density Overlay” (MDO), or “B-B High Density Concrete Form.” The number of pieces, size, and thickness should be noted in the same way as for other kinds of plywood. Special requirements, such as “High Density A-A”, “Medium Density B Inner Plies”, “Surfaced one side only”, or special weights of surfacing material include “High Density 60-60” (standard weight), and other weight variations such as 90-60, 90-90, 120-60, 120-120.
- (e) **Unsanded plywood sheathing**—The method of specifying plywood sheathing (C-D, C-C, Structural C-D and Structural C-C) is to designate the grade, Span Rating (see 3.8.5 and appendix A1), number of pieces, width, length, number of plies, and thickness.

If, for example, the requirement is 100 pieces of C-D, 48 inches wide by 96 inches long to be used for roof sheathing over rafters spaced 24 inches on center, this may be ordered as follows:

"C-D, 24/0 100 pcs., 48 inches by 96 inches, (3-or 5-ply), 3/8 inch thickness." (If exterior glue bond is desired add "exterior glue" or "Exposure 1".)

- (f) **Concrete Form plywood**—The method of specifying concrete form plywood is to designate the Class (I or II, see 3.6.4), number of pieces, width, length, thickness and grade. Concrete form panels are mill-oiled, unless otherwise specified.

If the requirement is 100 pieces of Class I Concrete Form plywood, 48 inches wide by 96 inches long by 5/8 inches thick, this may be ordered as follows:

"Concrete Form, Class I, 100 pcs., 48 in. by 96 in. by 5/8 in. thickness, B-B Exterior type."

A4. Shipment reinspection practices.

A4.1. General—Any request by the buyer for the reinspection of any item or lot of plywood certified as conforming to this Standard shall be directed to the seller. Lacking agreement of the buyer and seller as to the settlement of a complaint, the purchase, sale, or shipment of plywood certified as conforming to this Standard shall be construed as involving agreement to submit such plywood to reinspection by the qualified inspection agency whose grademark was used.

A4.2. Responsibility of the buyer—A request for reinspection may be made to the seller:

- (a) for panel grade—within 30 days⁹ after arrival at the first point of receipt from the mill, if the grade of any item, as invoiced, is in doubt;
- (b) for glue bond quality of Exterior type panels—when delamination is visibly evident;
- (c) for glue bond quality of Interior type panels bonded with exterior glue (Exposure 1)—within 6 months after arrival at first point of receipt from the mill, if delamination is visibly evident;
- (d) for glue bond quality of other Interior type panels—within 30 days⁹ after arrival at the first point of receipt from the mill, if delamination is visibly evident.

All plywood of disputed grade and Interior type plywood of disputed glue bond quality must be kept intact and properly protected from damage, deterioration and from direct exposure to moisture which could interfere with a fair reinspection. All plywood in question shall be held for a period not to exceed 30 days after the date of request for reinspection. Use by the buyer of any or all of the disputed stock within the 30 day period shall constitute an acceptance of the used portion.

A4.3. Responsibility of the seller—A request for reinspection shall be promptly acknowledged by the seller following its receipt.

A4.4. Cost and assistance—The expense of reinspection shall be borne by the seller if the item, lot, or shipment in dispute fails to pass the reinspection as provided for in A4.5. If the plywood passes the reinspection, said expenses shall be borne by the buyer. The buyer shall lend all reasonable assistance to facilitate the reinspection.

A4.5. Reinspection procedures and settlement.

A4.5.1. Condition of plywood—All plywood designated as complying with this Standard shall be subject to reinspection in the white (unfinished) only, except that concrete-form material may have a priming coat of oil or other clear preparation before inspection. The above requirement does not apply to Interior type plywood bonded with exterior glue (Exposure 1) or Exterior type plywood when tested for glue bond quality.

A4.5.2. Sampling for panel grade, size and thickness reinspections—At buyer's or seller's option, grade, size, and thickness reinspections may include all panels of an item whose conformance to this Standard is in dispute. However, buyer and seller may agree on a reduced basis for sampling provided at least 20 percent or 300 panels, whichever is smaller and which represents only those items as invoiced which are in dispute, are reinspected for conformance. For reduced sampling, the quantity of panels selected from each disputed item shall be prorated according to the number of panels included in each item as invoiced. Panels found to be below grade or out of tolerance for size and thickness shall have improper grademarks obliterated and shall be remarked with appropriate designation with a special inspection.

⁹For unitized shipments, the 30-day limit will be extended to include the period dating from receipt of shipment to breaking of the first bundle, but not exceeding 6 months, provided the requirement for keeping the disputed plywood intact is observed and the plywood in question is held for at least 30 days following the request for reinspection.

tion mark registered by the qualified agency conducting the reinspection and applied by that agency's authorized representative.

A4.5.3. Plywood panel grade, size and thickness reinspections—If reinspection establishes that a disputed item is more than 5 percent below grade or out of dimensional tolerance for the product description as invoiced, that item fails to pass the reinspection. The nonconforming panels need not be accepted, however, all other panels shall be accepted as invoiced. If reinspection establishes that a disputed item is 5 percent or less below grade or out of dimensional tolerance, it passes the reinspection and the buyer pays for them as invoiced. In addition to the above 5 percent grade and dimensional tolerance, a 5 percent tolerance shall apply separately to the inner ply gap limitations, including the limitations applicable to the plugged crossband and jointed crossband, as set forth in 3.8.1.

A4.5.4. Sampling for glue bond quality reinspections—For test purposes, twenty panels, or 5 percent of the panels, whichever is less, shall be selected at random from the item, lot, or shipment which is in dispute. The number of panels required is calculated by applying the "percent panels" to the lot size and converting part panels to whole panels by using a rounding procedure where 0.01 to 0.49 parts are considered to be the smaller whole number, while 0.50 to 0.99 parts are considered to be the larger whole number. These panels shall be selected from locations distributed as widely as practicable throughout the material being sampled. When an item, lot, or shipment involves panels with different adhesive bond requirements as provided for in 3.7, testing and evaluation shall apply separately to each category. Sampling shall include no less than 20 panels of Interior type Underlayment, C-D Plugged, and C-D. Sampling of Interior type (including the different adhesive qualities) or Exterior type, shall be prorated on the basis of ratio of their volume to total volume (i.e., for shipment containing 50 percent Exterior, 10 Exterior panels shall be selected), but in no case shall less than 10 panels of each type or adhesive quality be selected. Shipments of Interior type plywood bonded with exterior glue shall be sampled in the same manner as Exterior plywood.

From each of five of the panels selected, excluding Interior type panels bonded with interior glue, and from each of five of the overlaid panels selected, a 5-1/2 inch by 8 inch specimen shall be cut and tested as described in 4.5.4.

A4.5.5. Plywood glue bond quality reinspections—Reinspection of the unused panels in the disputed item, lot, or shipment shall be carried out following the procedures set forth, in Section 4, "Specimen Preparation and Testing," and A4.5.4 above. If the reinspection tests establish that the glue bond quality does not meet the requirements of 3.7, as applicable, the item, lot, or shipment fails to pass the reinspection and may be rejected by the buyer. If the glue bond quality requirements are met, the item, lot, or shipment passes the reinspection and the buyer must accept the item, lot, or shipment as invoiced, except that the buyer need not accept any delaminated Exterior type or overlaid panels.

A5. Metric conversion factors—The conversion factors and units contained in this appendix are in accordance with the International System of Units (abbreviated SI for Systeme International d'Unites). The SI was defined and given official status by the 11th General Conference on Weights and Measures which met in Paris in October 1960. For assistance in converting U.S. customary units to SI units, see ASTM E 380,¹⁰ *ASTM Standard Metric Practice Guide*. The conversion factors for the units found in this Standard are as follows:

1 inch = 25.4 millimeters

1 foot = 0.3048 meter

1 pound per square inch = $6.894\,757 \times 10^3$ pascals

1 pound force = 4.448 222 newtons

$t_C = (t_F - 32)/1.8$

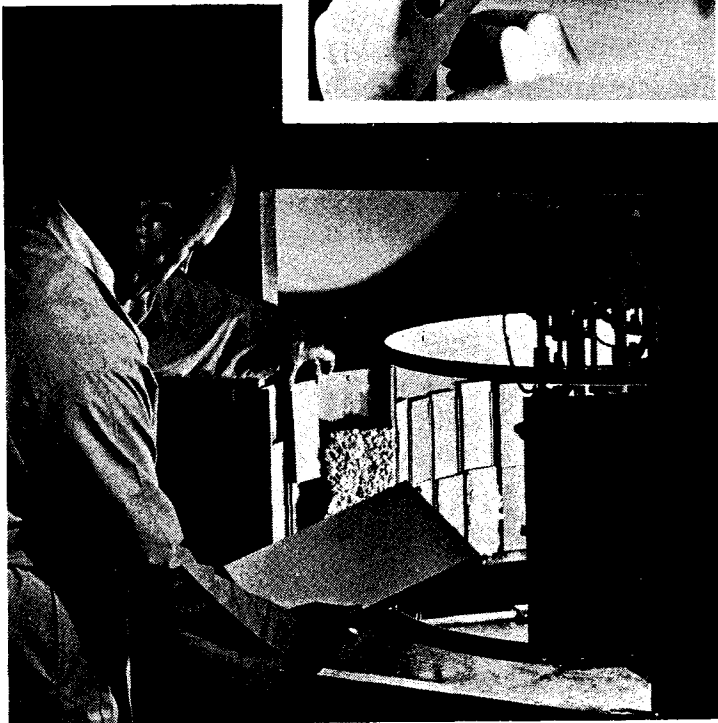
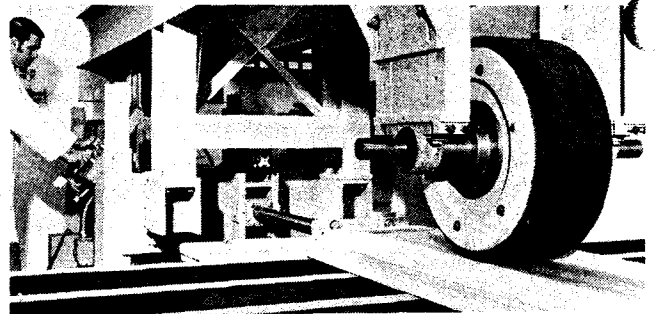
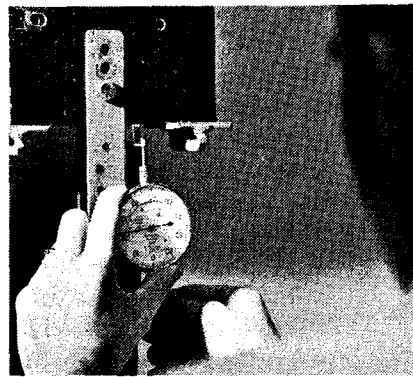
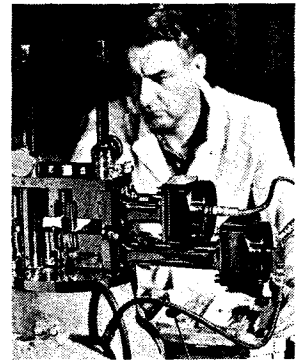
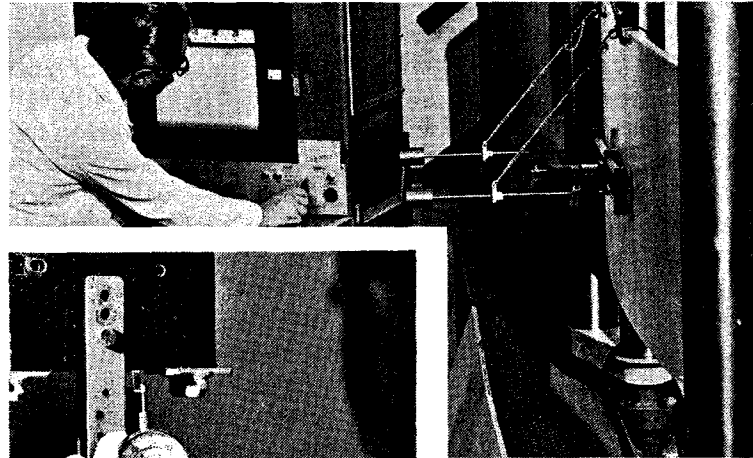
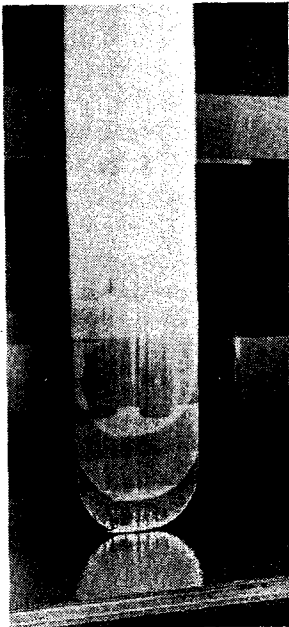
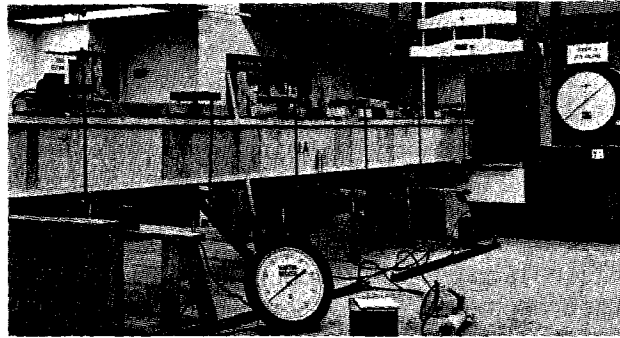
where:

t_C = temperature in degrees Celsius

t_F = temperature in degrees Fahrenheit

¹⁰See footnote 6 on page 27.

What's behind the trademarks of the American Plywood Association



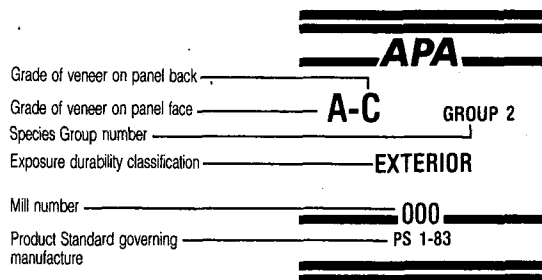
The American Plywood Association's 37,000-square-foot Research Center in Tacoma, Washington is the most sophisticated facility for basic panel research and testing in the world. The center is staffed with an experienced corps of engineers, wood scientists, foresters and wood product technicians. Their research and development assignments directly or indirectly benefit all specifiers and users of structural wood panel products.

How to read the basic trademarks of the American Plywood Association

Product Standard PS 1-83 is intended to provide for clear understanding between buyer and seller. To identify plywood manufactured by association member mills under the requirements of Product Standard PS 1-83, four types of trademarks and one typical edge mark are illus-

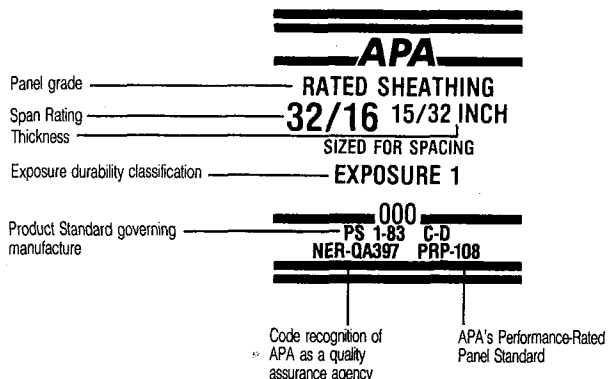
trated. They include the plywood's exposure durability classification; grade; and group, class or Span Rating. Here's how they look, together with notations on what each element means.

Sanded Grades

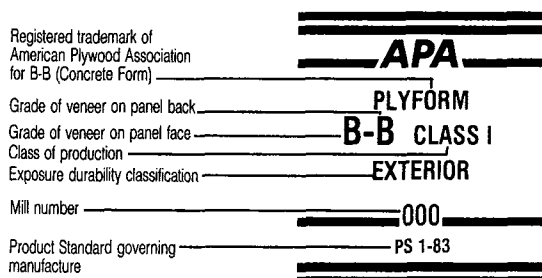


(Also available in Groups 1, 3 and 4)

Unsanded Grades

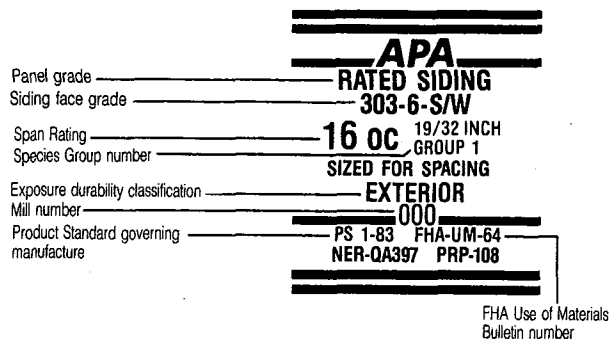


Concrete Form

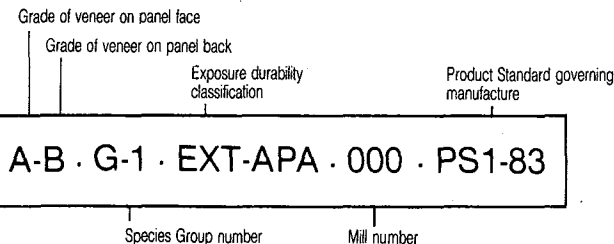


(Also available in Class II and HDO)

Specialty Panels



(Also available in Groups 2, 3 and 4)



Index to the typical registered trademarks and edge marks of the American Plywood Association.

<p>APA</p> <p>A-D GROUP 1 EXPOSURE 1</p> <p>000 PS 1-83</p> <p>(Also available in Groups 2, 3 and 4)</p>	<p>APA</p> <p>M. D. OVERLAY GROUP 1 EXTERIOR</p> <p>000 PS 1-83</p> <p>(Also available in Groups 2, 3 and 4)</p>	<p>APA</p> <p>B-C 15/32 INCH GROUP 1 EXTERIOR</p> <p>000 PS 1-83</p> <p>(Also available in Groups 2, 3 and 4)</p>
<p>MDO · B-B · G-2 · EXT-APA · 000 · PS1-83</p> <p>A-B · G-1 · EXT-APA · 000 · PS1-83</p>		
<p>APA</p> <p>RATED SHEATHING 32/16 15/32 INCH SIZED FOR SPACING EXPOSURE 1</p> <p>000 PS 1-83 C-D NER-QA397 PRP-108</p>	<p>APA</p> <p>RATED SHEATHING STRUCTURAL I 24/0 3/8 INCH SIZED FOR SPACING EXPOSURE 1</p> <p>000 PS 1-83 C-D NER-QA397 PRP-108</p> <p>(Also available as Structural II. Both made only with exterior glue)</p>	<p>APA</p> <p>RATED STURD-I-FLOOR 20 oc 19/32 INCH SIZED FOR SPACING T&G NET WIDTH 47-1/2 EXPOSURE 1</p> <p>000 PS 1-83 UNDERLAYMENT NER-QA397 PRP-108</p>
<p>APA</p> <p>UNDERLAYMENT 11/32 INCH GROUP 1 EXPOSURE 1</p> <p>000 PS 1-83</p> <p>(Also available in Groups 2, 3 and 4)</p>	<p>APA</p> <p>RATED SHEATHING 48/24 23/32 INCH SIZED FOR SPACING EXTERIOR</p> <p>000 PS 1-83 C-C NER-QA397 PRP-108</p>	<p>APA</p> <p>C-C PLUGGED GROUP 1 EXTERIOR</p> <p>000 PS 1-83</p> <p>(Also available in Groups 2, 3 and 4)</p>
<p>HDO · B-B · PLYFORM I · 60/60 · EXT-APA · 000 · PS1-83</p>		

We have field representatives in most major U.S. cities who can help. For additional assistance in specifying APA panel products, get in touch with your nearest American Plywood Association regional office. Call or write:

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Suite 211
Dallas, Texas 75238
(214) 348-0643

NORTHEASTERN REGION

Joe Owens
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(703) 750-3993

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The panel use recommendations in this publication are based on the American Plywood Association's continuing program of laboratory testing, product research and comprehensive field experience. However, because the Association has no control over quality of workmanship or the conditions under which panel products are used, it cannot accept responsibility for panel performance or designs as actually constructed.